Tigers
Unveiled

A BIBLIOGRAPHIC ODYSSEY
(2019-2023)

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(2019-2023)

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MANOJ DHOLAKIA

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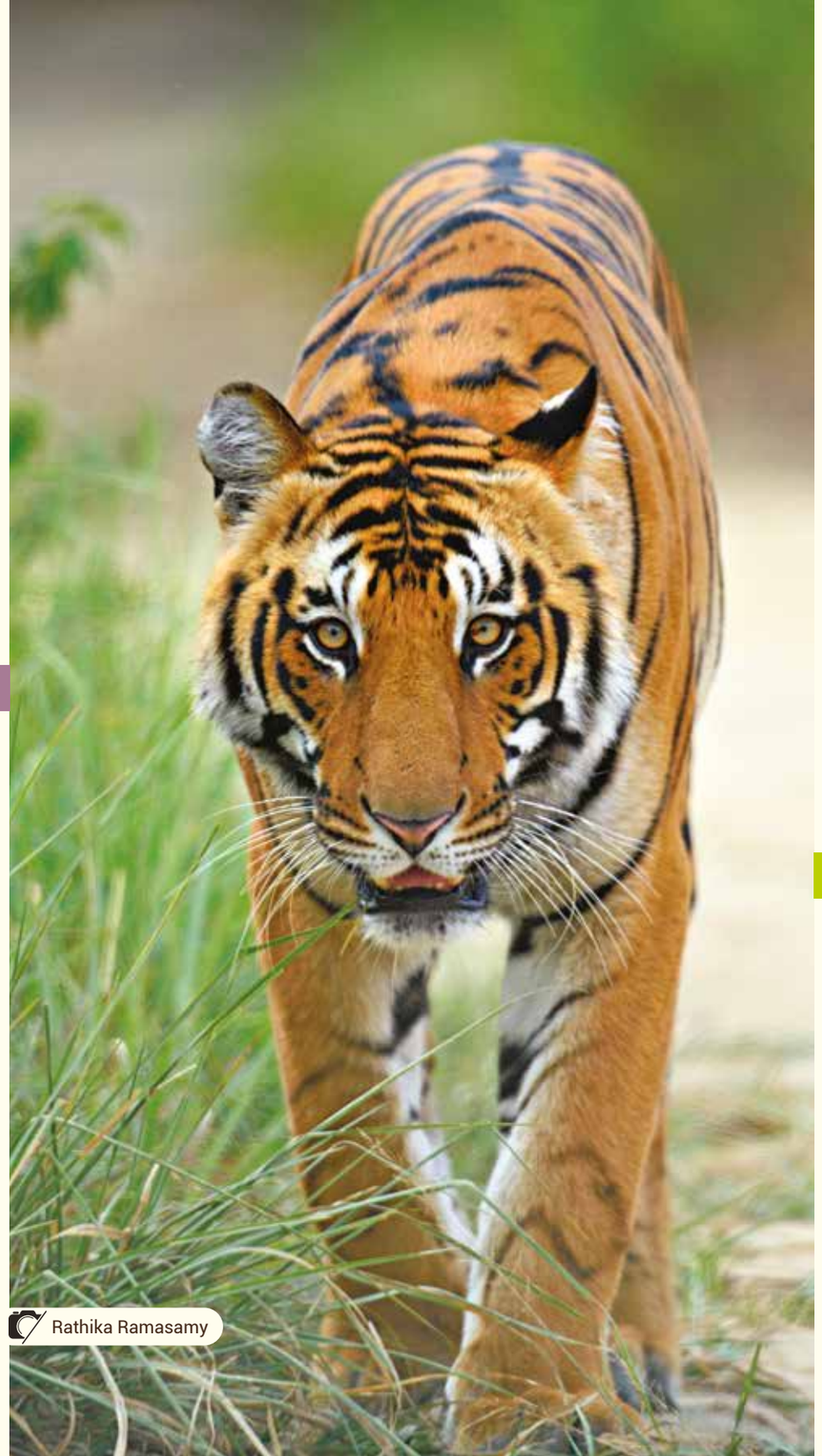
SHIVANG MEHTA

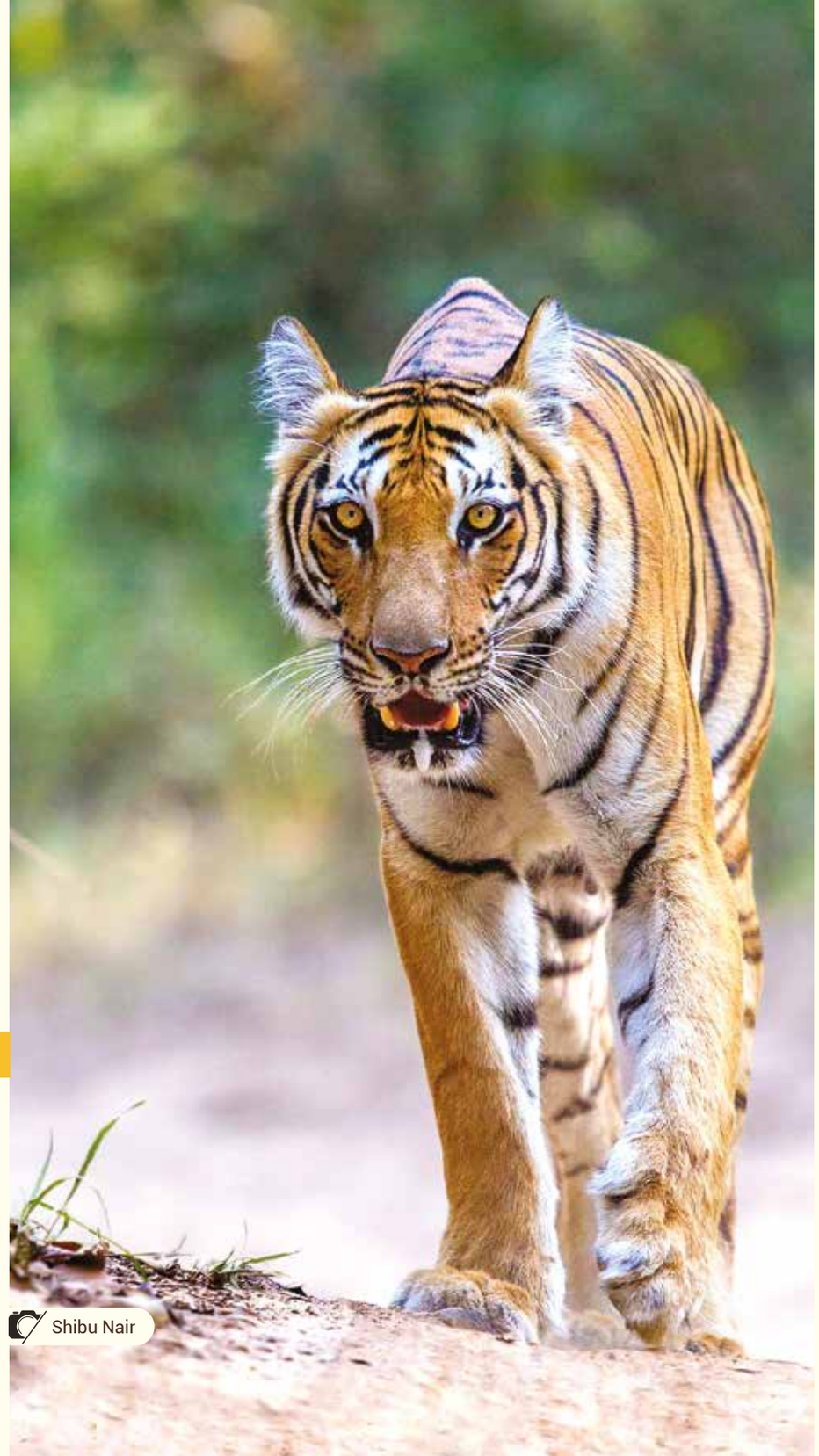
CONTENT

Nilanjan Chatterjee

CONTENT


Rathika Ramasamy

CONTENT



Shibu Nair

INTRODUCTION

Tigers, often regarded as charismatic and majestic apex predators, have captivated the imagination of researchers, conservationists, and enthusiasts alike. This bibliography record book is the result of a comprehensive search for scholarly articles, research papers, books, policy documents and other publications that shed light on various aspects of tigers and their conservation around the globe. To initiate this endeavor, we utilized a carefully selected set of keywords related to tigers, their biology, conservation, habitats, and associated issues.

This bibliography holds immense significance for the conservation of tigers and serves as a vital resource for researchers and conservation practioners engaged in this field. The importance lies in its ability to not only consolidate the knowledge amassed over this period but also to guide and inspire new research initiatives. Researchers can access this repository to gain insights into the most recent advancements, identifying gaps in knowledge and avenues for further exploration. Moreover, it provides a valuable reference tool for policymakers, conservationists, and educators, offering a structured source of information essential for evidence-based decision-making and educational outreach. Ultimately, this bibliography plays a pivotal role in facilitating a holistic understanding of tiger conservation, contributing to more informed, effective, and collaborative efforts to safeguard these iconic big cats and their habitats.

While the Global Tiger Forum (GTF) has admirably compiled a bibliography on tigers up to 2018, this bibliography stands apart in several ways. What sets the current bibliography apart from the earlier work by the Global Tiger Forum (GTF) is a commitment to staying current, an organized thematic categorization, and the provision of additional resources. This bibliography is organized into distinct thematic categories, encompassing areas such as genetics, sustainable solutions, biology and animal welfare. This categorization allows for streamlined research and enhances accessibility, offering a structured approach for users to explore the vast body of literature. It goes beyond a mere list of references; it serves as a comprehensive framework for further in-depth study.

Furthermore, what truly distinguishes our bibliography is the provision of abstracts for the listed references, offering concise summaries of key findings, objectives, and methodologies. This additional layer of information enables users to quickly assess the relevance of each article before delving into the full text.

Our search strategy aimed to encompass the most pertinent and up-to-date literature on tigers, as we recognize the urgent need to address the challenges these magnificent creatures face in the wild. The keywords employed in our search included “tigers”, “Panthera tigris”, “tiger conservation,” “tiger ecology,” “tiger behavior,” “tiger populations,” “tiger habitats,” “tiger threats,” and “tiger conservation strategies.” These keywords were chosen to ensure a more consolidated yet multifaceted exploration of the subject.

Throughout our extensive search across various academic databases, libraries, and scholarly repositories, we identified 1,521 articles and publications that contribute significantly to the understanding of tigers and the conservation efforts aimed at their protection. The diversity of these sources allows us to categorize and organize them into thematic areas, making it easier for researchers, conservationists, and interested readers to access information on specific aspects of tiger biology, conservation, and associated challenges.
In this bibliography record book, we have divided the collected articles into thematic areas to provide a clear and structured literature overview (figure1). The broad thematic areas include but are not limited to:

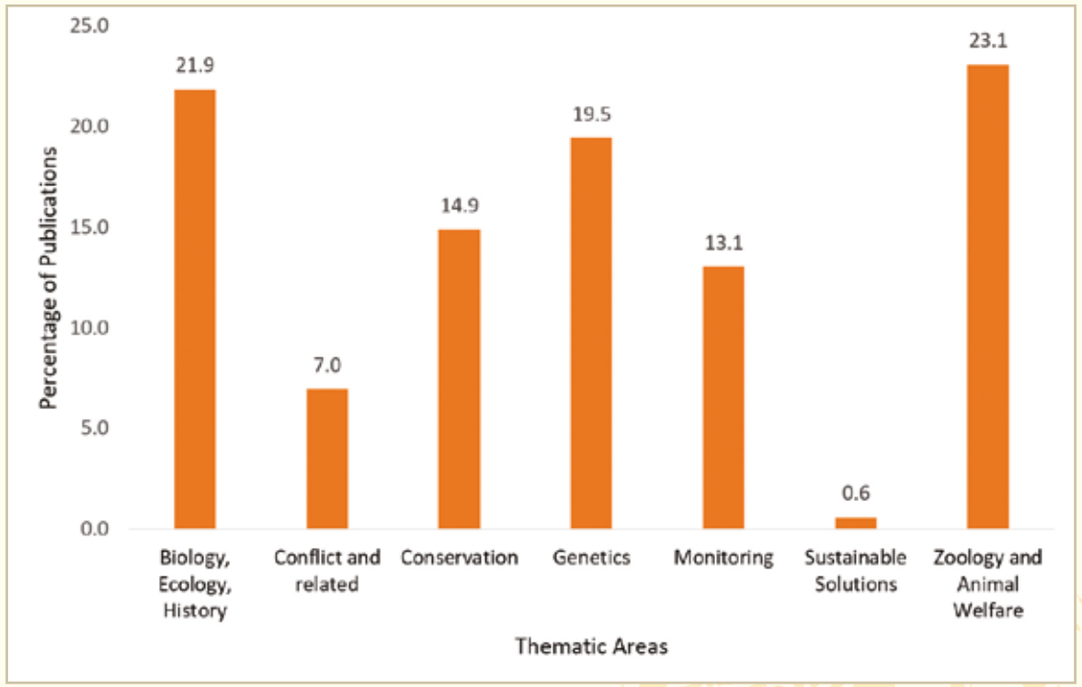


***Figure 1**. Graph depicting the percentage of publications in various thematic area from 1950 to 2023.*

Tiger Biology, Ecology and Natural History:
This category delves into the fundamental aspects of tiger life, exploring their natural history and biology, behavior, and ecology. It provides a deep understanding of how tigers interact with their environment and adapt to their surroundings.

Tiger Conservation and Management, Policy Recommendations:
Under this category, we examine the myriad challenges and strategies surrounding tiger conservation. This category encompasses not only conservation approaches but also policy recommendations and the role of tourism in tiger protection and local economies.

Monitoring and Assessment (population survey and habitat assessment):
Understanding the current status and distribution of tiger populations is vital for effective conservation. This category focuses on studies that evaluate population trends and monitor tiger habitats.

Genetics and Forensics:
Genetics plays a crucial role in tiger conservation. This category explores the genetic diversity and health of tiger populations, which are fundamental to their long-term survival.

Zoology and Animal Welfare (Health and Disease):
The well-being of tigers, including their health and management, is a critical aspect of conservation. Articles in this category delve into the veterinary care and welfare of tigers in captivity and in the wild.

Human Tiger Interaction and Conflict Mitigation:
Tigers often come into contact with human populations, leading to conflicts. This category addresses the complex issue of human-tiger conflict and the strategies for mitigating these conflicts.

Sustainable Solutions and Technology Advancement:
In the face of numerous challenges, this category presents research and studies that propose sustainable solutions for tiger conservation. It highlights the importance of local community involvement, governmental policies, and international collaboration in securing the future of tigers in the wild.

By categorizing these resources into thematic areas, we aim to facilitate easier access and navigation for those interested in specific facets of tiger research and conservation.

We hope this bibliography record book serves as a valuable resource for researchers, students, conservationists, and anyone passionate about the preservation of these magnificent creatures in the wild.

During our investigation, we found a wealth of articles and publications across multiple regions, with India, China, Russia, and Indonesia emerging as the primary contributors to the pool of knowledge on tigers (figure 2).

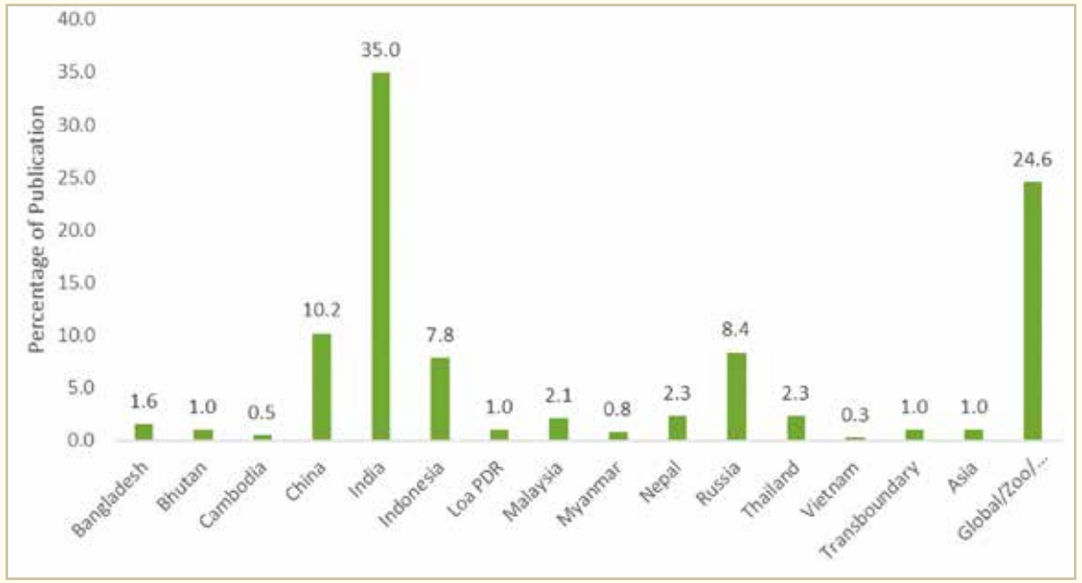


***Figure 2**. Graph depicting Global Contributions to Tiger Research Publications by Country.*

India, a nation with a rich cultural heritage deeply intertwined with the tiger, has exhibited a remarkable dedication to tiger conservation and research. This commitment is reflected in the substantial number of articles originating from Indian researchers and institutions. Following closely behind, China, Russia, and Indonesia have also made significant contributions in publications, emphasizing the global importance of tiger conservation efforts (figure 3).

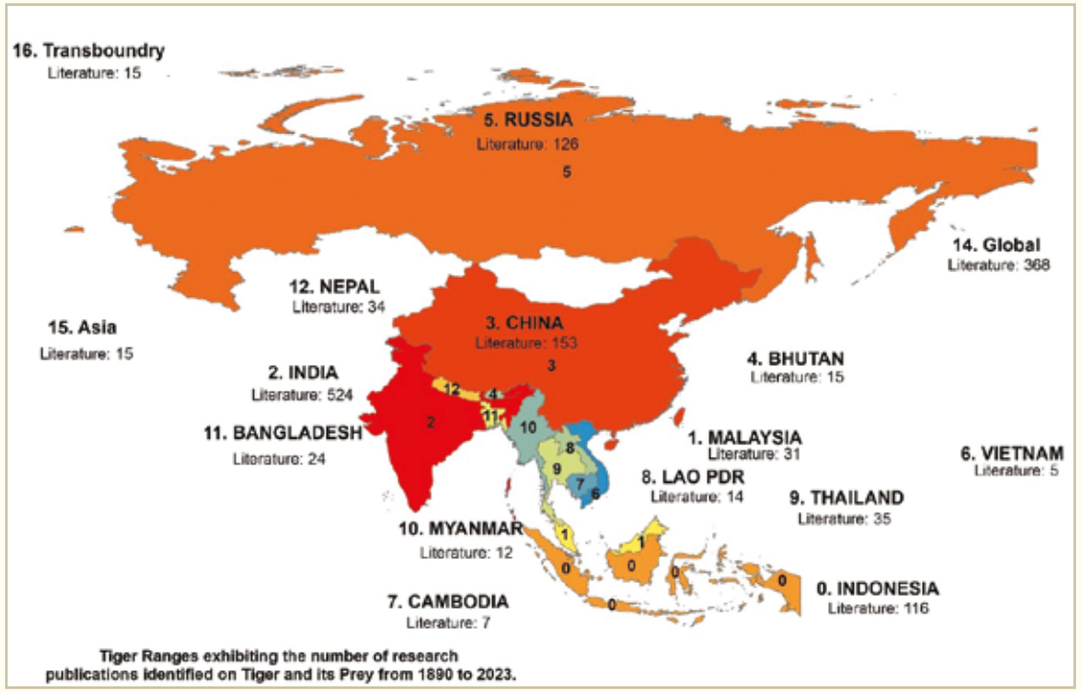


***Figure 3**. Geographic Distribution of Tiger Research Publications*

The thematic areas into which we have categorized these articles shed light on the diversity of perspectives and research interests surrounding tigers. Notably, the field of zoology and animal welfare has garnered the largest number of articles. These contributions delve into the biology, behavior, and welfare of tigers, providing a holistic understanding of their lives and the challenges they face.

Furthermore, genetics, conservation, and monitoring are prominent areas of study, reinforcing the importance of genetics in population management and the ongoing conservation and monitoring efforts to safeguard these magnificent creatures.

STATS FROM 2019 TO 2023

As of October 2023, the world of tiger literature continues to flourish, with 599 noteworthy publications identified from the year 2019. India, once again, takes center stage in the world of tiger literature **(Table 1)**. In these years, two thematic areas stand out as the focal points of India's tiger literature - Biology, Ecology, and Natural History followed by Monitoring and Population Estimation of Tigers **(Table 1)**. Globally, the trends in tiger literature reflect a comprehensive approach **(Table 1)**. While zoology and animal welfare continue to gain attention, with a focus on the ethical and welfare considerations shaping conservation practices, the timeless subjects of Biology, Ecology, and Natural History remain at the core. These topics serve as the foundation for effective tiger conservation, essential for ensuring the longevity of these apex predators.


Manoj Dholakia

***Table 1**: Number of literatures on Tiger within various thematic area, from 2019 to 2023 (October) across Tiger ranges and around the world.*

	Biology	Conflict	Conservation	Genetics	Monitoring	Technology	Tourism	Zoology	**Grand Total**
Asia	4		3		1			1	9
Bangladesh	1		1	1				2	5
Bhutan	3		3		5			1	12
Borneo	2								2
Cambodia	2		2						4
China	10		10	17	13	4		20	74
Global	20	1	14	9	4	2		90	140
India	62	18	35	25	37	8	1	17	203
Indonesia	14	9	6	6	10			8	53
Lao PDR	1		1		1				3
Malaysia	3		1		1			2	7
Myanmar	2				2				4
Nepal	8	7	9		5			4	33
Russia	4		4	1	3			7	19
Thailand	10				8			4	22
Tiger Range Countries			1						1
Transboundary	1		4		1				6
Vietnam			2						2
Grand Total	**147**	**35**	**96**	**59**	**91**	**14**	**1**	**156**	**599**

***Table 2:** Number of literatures on Tiger within various thematic area, for 2019 across Tiger ranges and around the world.*

	Biology	Conflict	Conservation	Genetics	Monitoring	Technology	Zoology	**Grand Total**
Asia	1		1		1			3
Bangladesh							1	1
Bhutan					2			2
Borneo	2							2
Cambodia			1					1
China	3			1	7		3	14
Global	3		3		1	1	12	20
India	9	4	9	7	4		4	37
Indonesia	2		2	2	1		1	8
Lao PDR			1					1
Myanmar					1			1
Nepal	5	3	1		1		2	12
Russia	1				1			2
Thailand	3				1		2	6
Transboundary			1		1			2
Grand Total	**29**	**7**	**19**	**10**	**21**	**1**	**25**	**112**

***Table 3**: Number of literatures on Tiger within various thematic area, for 2020 across Tiger ranges and around the world.*

	Biology	Conflict	Conservation	Genetics	Monitoring	Technology	Tourism	Zoology	**Grand Total**
Asia	1		1						2
Bangladesh	1								1
Bhutan			2						2
Cambodia			1						1
China			3	1	2	3		5	14
Global	5		1					20	26
India	16	2	8	2	8	1	1	3	41
Indonesia	3		2		1				6
Malaysia	1				1				2
Myanmar	1								1
Nepal		1	2		1				4
Russia								2	2
Thailand					2				2
Tiger Range Countries			1						1
Vietnam			2						2
Grand Total	**28**	**3**	**23**	**3**	**15**	**4**	**1**	**30**	**107**

***Table 4**: Number of literatures on Tiger within various thematic area, for 2021 across Tiger ranges and around the world.*

	Biology	Conflict	Conservation	Genetics	Monitoring	Technology	Zoology	**Grand Total**
Bangladesh				1			1	2
Bhutan	1		1				1	3
China	2		2	6			5	15
Global	4		6	5	2		18	35
India	14	7	3	8	9	2	1	44
Indonesia	5	3	1		3		2	14
Lao PDR					1			1
Malaysia	1		1					2
Nepal		1	2		1		1	5
Russia	3		3	1	1		3	11
Thailand	4				3			7
Transboundary	1							1
Grand Total	**35**	**11**	**19**	**21**	**20**	**2**	**32**	**140**

Table 5: *Number of literatures on Tiger within various thematic area, for 2022 across Tiger ranges and around the world.*

	Biology	Conflict	Conservation	Genetics	Monitoring	Technology	Zoology	**Grand Total**
Asia	1							1
Bhutan	1							1
Cambodia	2							2
China	4		4	6	2	1	7	24
Global	6		3	2	1	1	24	37
India	13	5	7	7	5	2	6	45
Indonesia	2	3		2	5		4	16
Lao PDR	1							1
Myanmar					1			1
Nepal	1	1	1		1			4
Russia			1		1		1	3
Thailand	1				1		1	3
Transboundary			2					2
Grand Total	**32**	**9**	**18**	**17**	**17**	**4**	**43**	**140**

Table 6: *Number of literatures on Tiger within various thematic area, for 2023 across Tiger ranges and around the world.*

	Biology	Conflict	Conservation	Genetics	Monitoring	Technology	Zoology	**Grand Total**
Asia	1		1				1	3
Bangladesh			1					1
Bhutan	1				3			4
China	1		1	3	2			7
Global	2	1	1	2			16	22
India	10		8	1	11	3	3	36
Indonesia	2	3	1	2			1	9
Malaysia	1						2	3
Myanmar	1							1
Nepal	2	1	3		1		1	8
Russia							1	1
Thailand	2				1		1	4
Transboundary			1					1
Grand Total	**23**	**5**	**17**	**8**	**18**	**3**	**26**	**100**

GAPS IN RESEARCH

Even with a substantial body of literature on tigers there persist key research gaps in tiger research across their range, which can be categorized into the following areas:

Habitat loss and degradation: The loss of tiger habitat due to deforestation, agriculture, and urbanization is a significant threat to tiger populations. Research is needed to identify and protect crucial habitats and corridors for tigers, as well as to address the drivers of habitat loss, such as poaching and land use change.

Climate change and land use change: The impact of climate change on tiger habitats and populations is not yet fully understood. Research is needed to determine the potential effects of climate change on tiger distribution and to develop strategies for adapting conservation efforts accordingly. We also need to focus on role of tiger conservation as a strategy for climate change mitigation.

Human-tiger conflict: The expansion of human populations and infrastructure development can lead to conflicts with tigers, resulting in human injuries and tiger deaths. Research is needed to understand the factors contributing to human-tiger conflict and to develop effective strategies for mitigating it.

Coexistence with humans: Ensuring the survival of tigers while also protecting human interests is a challenging task. Research is needed to explore the potential for human-tiger coexistence, including the development of community-based conservation strategies and the management of natural resources.

Monitoring and research gaps: There is a need for long-term monitoring and research to understand the dynamics of tiger populations and their habitats. This includes the use of advanced technologies, such as genetic monitoring and remote sensing, to track tiger movements and monitor their impact on ecosystems.

Expanding tiger range: Research has shown the potential to more than double the tiger range in Asia, with the identification of range recovery areas in 10 current tiger range countries and five where tigers are believed to have gone extinct.

Research is needed to assess the feasibility of expanding tiger habitats and to develop strategies for achieving this goal.

By addressing these research gaps, conservation efforts can be better informed and prioritized to ensure the survival and recovery of tiger populations across their range.

STRUCTURE LAYOUT OF THE BOOK

Imagine our book about tigers is like a library where all the articles are neatly organized. We've decided to organize these articles in a special order to make it easier for everyone to find what they're looking for.

Firstly, we're grouping the articles by the year they were published. So, let's say we start with articles from the year 2019. Then, within 2019, we're sorting the articles based on the countries they're from. For instance, we'll gather all the articles from India first, and then we'll group these Indian articles by the different topics they cover, like tiger behavior, habitats, conservation, and so on.

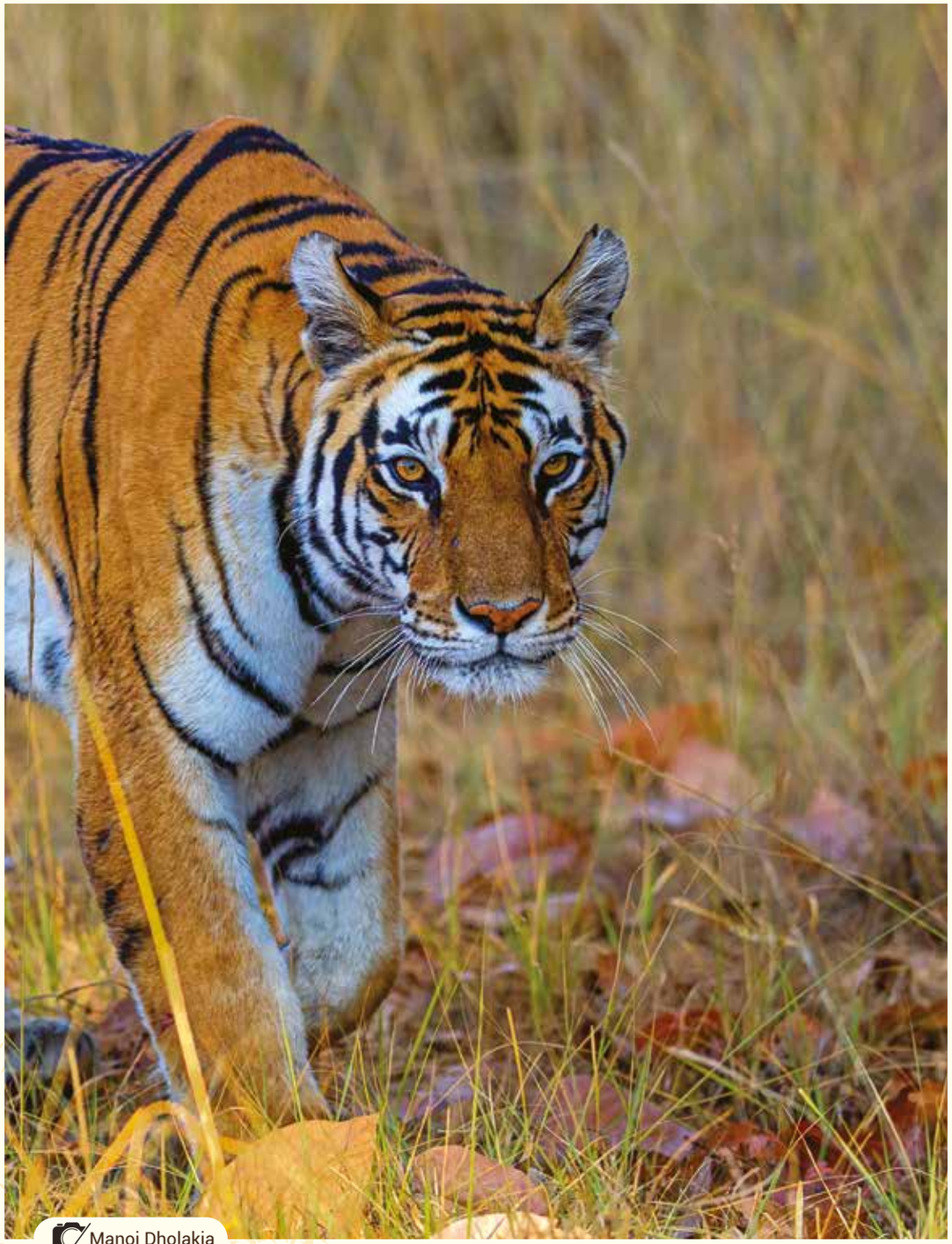
Once we've covered all the articles from India in 2019, we'll move on to another country, like the United States or Russia, and organize their articles in the same way, by themes.

After we finish sorting all the articles from 2019 by country and theme, we'll move on to the next year, like 2020, and repeat the process all over again. This way, readers can easily find articles about tigers from a specific year, country, or topic they're interested in, making our book like a map to explore all the amazing research done on tigers.

Additionally, for each article, we're providing a summary or an abstract. This brief description highlights the main points of the article, giving readers a sneak peek into what it's about before they dive in.

This structure will be incredibly helpful for readers, as they can quickly find articles about tigers published in a specific year, from a particular country, or focusing on a certain aspect of tiger conservation. It's like having a roadmap that guides you to the information you need, making it convenient and efficient for anyone interested in learning more about tiger research.

Photo from Internet



Manoj Dholakia

ASIA

2019

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Ecology

Li, Z., Wang, T., Smith, J. L. D., et al. (2019). Coexistence of two sympatric flagship carnivores in the human-dominated forest landscapes of Northeast Asia. Landscape Ecology, 34(2), 291–305. *https://doi.org/10.1007/s10980-018-0759-0*.

ABSTRACT

Understanding how large carnivore guilds survive in human-dominated landscapes is key to inform strategies for their conservation in the face of global carnivore declines. Amur tigers and leopards are recovering across the China-Russia border. However, knowledge is limited about competitive interactions between two large cats in Northeast Asia. To assess the spatial, temporal and combined spatiotemporal behavioral mechanisms potentially allow co-occurrence between tigers and leopards in a human-dominated forest landscape. Based on a large-scale camera-trapping data set in Northeast China, we used three different approaches for quantifying spatiotemporal associations: one spatial method (two-species occupancy model), one strictly temporal method (activity pattern overlap), and one spatiotemporal method based on multi-response permutation procedures at shared camera trap sites. Spatially, leopards showed no avoidance of the areas highly used by dominant tigers, but their diurnal activity pattern was significantly different from that of tigers. Spatiotemporal overlap analysis showed fine-scale behavioral avoidance when both co-occurred at camera locations, which further facilitates sympatry. Tigers spatially overlapped with humans, but they were less active during the day when human activities were more frequent. In areas with high cattle density, low occurrence of tigers and leopards may reflect the absence of sika deer, an important prey item for both species. This study provides the first empirical evidence that tigers do not limit leopard distributions, at least in our study area in Northeast Asia. Our results highlighted temporal segregation, not large-scaled spatial avoidance, as a key mechanism promoting coexistence of two large carnivores. Understanding these fine- spatial scale (i.e., camera locations) interactions between sympatric carnivores can help devise management strategies for predator guilds in human-dominated landscapes, currently a major global challenge.

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATIONS

Farhadinia, M. S., Maheshwari, A., Nawaz, M. A., Ambarlı, H., Gritsina, M. A., Koshkin, M. A., Rosen, T., Hinsley, A., and Macdonald, D. W. (2019). Belt and Road Initiative may create new supplies for illegal wildlife trade in large carnivores. Nature Ecology and Evolution, 3(9), 1267–1268. *https://doi.org/10.1038/s41559-019-0963-6*.

ABSTRACT

The article addresses the concerning impact of China's Belt and Road Initiative (BRI) on illegal wildlife trade in west and central Asia. Highlighting the potential risks posed by the BRI's infrastructure development to key habitats of endangered species like large carnivores, the authors emphasize the increased access and supply corridors that could escalate the illicit wildlife trade in the region. The BRI's connectivity and accessibility might fuel the demand for wildlife products in China and Southeast Asia, endangering species like Persian leopards, Asian brown bears, and snow leopards. The article offers specific recommendations to mitigate these risks, including addressing human-carnivore conflicts, enhancing detection mechanisms for illegal trade, fostering transboundary partnerships, and advocating for a better understanding of species movement and demographics. The authors stress the urgency of implementing these measures to safeguard biodiversity and combat illegal wildlife trade amid the expansive reach of the BRI in these critical habitats.

MONITORING AND ASSESSMENT

Schnitzler, A. and Hermann, L. (2019). Chronological distribution of the tiger Panthera tigris and the Asiatic lion Panthera leo persica in their common range in Asia. Mammal Review, 49, 340-353. *https://doi.org/10.1111/mam.12166*.

ABSTRACT

Highly mobile creatures with remarkable exploratory behaviour, the modern tiger Panthera tigris and the modern Asiatic lion Panthera leo persica colonised Eurasia during the Late Pleistocene (from 126000 ± 5000 to 11700 years before present, BP) and the Holocene (from 11700 BP to the present day). Their respective ranges have overlapped several times but we tend to ignore the extent to which they have really coexisted because this situation has not occurred in recent times. We provide a state-of-the-art review of all the data covering their chronological distribution, in order to evaluate the extent to which they have coexisted. We include new data from petroglyph analysis in Central Asia. The data set covers two major biogeographical regions: the Palearctic Biogeographic Realm (western Asia and Central Asia) and the Indo-Malaysian Biogeographic Realm in Monsoon Asia. Lions and tigers shared space with a large variety of medium-sized carnivores. We can hypothesise that, due to the plentiful prey and the diversity in habitats within their common range, they lived in sympatry there during the Holocene (although in local allopatry), as long as human interference was low. The Indo-Malaysian Biogeographic Realm offered the best habitats for coexistence due to the tropical climate, the variety of habitats, and the great diversity in prey. In temperate Asia, the carrying capacity was naturally lower due to cold winters and dry summers, except along the coasts. Suitable habitats were limited, in Central Asia, to the tugais of the alluvial valleys and the adjacent steppes. In this region, lions were particularly sensitive to stresses, due to their low adaptability to harsh winters, the long distance to their main population sources, and the likelihood that they were pushed into the steppes by tigers, where they were killed by humans, for symbolic or pragmatic reasons.

Photo from Internet

BANGLADESH

ZOOLOGY AND ANIMAL WELFARE

Ghosh, S. K., Bupasha, Z. B., Nine, H. S. M. Z., Sen, A., Ahad, A., and Sarker, M. S. (2019). Antibiotic resistance of Escherichia coli isolated from captive Bengal tigers at Safari parks in Bangladesh. Journal Of Advanced Veterinary and Animal Research, 6(3), 341–345. *https://doi.org/10.5455/javar.2019.f352*.

ABSTRACT

Objectives: The present study was carried out to assess the antibiotic resistance and to identify the resistance genes in Escherichia coli from captive Bengal tigers at two Safari parks in Bangladesh.

Materials and methods: A number of 24 environmental fecal swab samples of Bengal tigers were collected from two different Safari parks in Bangladesh. For the isolation of E. coli, samples were submitted to a number of bacteriological screening and biochemical tests. The antibiotic susceptibility of E. coli isolates was determined by disk diffusion method.

Results: Results demonstrated that 18 environmental fecal samples were positive to E. coli in bacteriological screening and biochemical test. The overall prevalence of E. coli in Bengal tiger was 75% (n = 18/24). The antibiogram study unveiled that all the isolates were resistant to ampicillin. Sulfamethoxazole-trimethoprim, nalidixic acid, and tetracycline were 89% (n = 16/18) resistant. On the contrary, 100% (n = 18/18) of the isolates were sensitive to colistin sulfate.

Photo from Internet

bla TEM was detected in 78% (n = 14/18) ampicillin-resistant isolates, whereas sul2 was found in 31% (n = 5/16) of the sulfamethoxazole-trimethoprim-resistant isolates.

Conclusion: This study, first time in Bangladesh, highlights a significant proportion of environmental fecal samples from captive Bengal tigers at Safari parks harboring antibiotic resistant E. coli. Transmission of resistant E. coli from Bengal tigers to humans and the environment could pose a public health risk at Safari parks in Bangladesh.

BHUTAN

MONITORING AND ASSESSMENT

Dorji, S., Rajaratnam, R. and Vernes, K. (2019). Mammal richness and diversity in a Himalayan hotspot: the role of protected areas in conserving Bhutan's mammals. Biodiversity Conservation 28, 3277–3297. *https://doi.org/10.1007/s10531-019-01821-9*.

ABSTRACT

Photo from Internet

More than 51% of Bhutan is in a protected area (PA) network and our study demonstrates its effectiveness in conserving large and medium mammal species. We conducted camera trapping in Bhutan's PAs, biological corridors (BCs) and intervening non-protected areas (NPAs) to investigate the richness and diversity of mammals, and assess the network's efficacy in protecting mammals. 1858 camera traps were deployed within 1129 5-km × 5-km grids over 536 days between 2014 and 2015, resulting in 148,598 trap-nights (mean = 80 traps-nights/camera) which yielded nearly 10 million photos (mean = 5368 photos/camera trap). Fifty-six mammal species (65% of Bhutan's 86 medium and large terrestrial mammal species) representing 18 families within seven orders were identified, of which, 18 (32.16%) are listed as threatened by the International Union for Conservation of Nature. There was a significant difference in mammal diversity between PAs, BCs, and NPAs (PERMANOVA test; $p < 0.001$; Pseudo-F = 6.40; unique perms = 9921), with the strongest difference between PAs and NPAs. Additionally, Hill's numbers q = 0 (species richness), q = 1 (Shannon's entropy index) and q = 2 (Simpson's concentration index) revealed a higher mammal diversity in PAs compared to BCs and NPAs. Higher mammal diversity in PAs can be attributed to the added presence of threatened species, including the tiger Panthera tigris, red panda Ailurus fulgens, Asian elephant Elephas maximus, and golden langur Trachypithecus geei. However, BCs and NPAs share similar patterns of mammal diversity, and globally threatened species such as the Chinese pangolin Manis pentadactyla and Indian pangolin Manis crassicaudata were only detected in NPAs. Although Bhutan's PA network is effective in conserving much of the country's mammal diversity, realignment of some protected areas and biological corridors would ensure the long-term protection of several threatened mammal species.

Tashi, D. (2019). Tiger Monitoring in Bhutan Using Non-invasive Genetic Tools. (Master's thesis), The University of Montana, Missoula, MT.

ABSTRACT

Large carnivores are one of the most threatened group of animals in the world. They suffer from prey depletion, persecution by humans, and habitat loss and fragmentation which are extensively driven by anthropogenic activities. One such species is the tiger Panthera tigris. Tigers are found in thirteen countries in Asia and are protected across the range; however, tiger numbers have declined as an after effect of habitat loss, prey depletion and poaching. Human-induced changes have reduced the tiger's historical range to about 7% in which a little more than 3900 tigers are found. Most of these individuals currently exist in small and highly structured populations. Obtaining reliable estimates of population size and density and a solid understanding of the connectivity between populations are critical to understanding crucial aspects of effective tiger conservation. Bhutan, with a vast expanse of contiguous pristine forest cover, abundant prey, and active conservation policies, form a very critical part of tiger conservation in South Asia. However, due to limited funds, monitoring is erratic. Camera traps are a sought-after tool for monitoring tiger population and density in Bhutan, but costs have been a limiting factor. Therefore, we evaluated non-invasive genetic sampling (NGS) as an effective alternative to camera trapping for monitoring tigers in Bhutan. We carried out systematic camera trap and scat surveys in Royal Manas National Park in Southern Bhutan in 2018 and compared density, variability, and costs between the two methods. The densities were estimated under a spatially-explicit capture-recapture framework, and camera trap and NGS produced a density of 2.38 tigers/100 km^2 (95% CI 1.11-4.02) and 3.6 tigers/100km^2(95% CI 1.06-12.23) respectively. Density and other parameters were estimated more precisely using camera traps, but the field and equipment cost was high as compared to single-session genetic sampling. When controlled for sampling effort, NGS performed better. There is also no information regarding population connectivity and gene flow in tigers within Bhutan. We genotyped 24 individuals using thirteen microsatellite loci and found that Bhutanese tigers overall have a high genetic variation (He=0.75). Individual-based and multivariate analyses indicated three genetic clusters within the sampled individuals; however, the overall genetic differentiation was low (FST=0.44). Our results suggest that Bhutanese tigers can be a source of genetic variation in the region and could play a crucial role in the long-term persistence of the species. We strongly recommend a transboundary and landscape-level conservation approach using common genetic data sets to understand tiger dispersal, threats, and other factors influencing dispersal events.

BORNEO

BIOLOGY, ECOLOGY AND NATURAL HISTORY

History

Sellato, B. (2019). The Other Tiger: History, Beliefs, and Rituals in Borneo. Temasek Working Paper Series, 1, 1-69.

ABSTRACT

Photo from Internet

Borneo has so far remained marginal in studies on Southeast Asian peoples and tigers. While the tiger is not known to exist in Borneo today, it has a significant reality in historical traditions, oral literature, myths, beliefs, and rituals. This study combines various materials about Borneo, with a primary focus on its central regions, in order to, ultimately, try to shed light on ancient belief systems and the modalities of their evolution through time and cultural contact. It first surveys the local Felidae species, the names given to the tiger, and the presence of tiger body parts among villagers. Then, it reviews representations of the tiger in oral literature, its value as a symbol of martial manliness and, locally, its standing as a culture hero, and looks at religious beliefs, the tiger's ambivalent nature, and its function as mediator between humans and spirits. Focusing on rituals, it then stresses its benevolence (initiation, redemption, purification), as well as its sinister facets (punishment for breach of taboos), both meant to warrant a 'cool' socio-cosmic balance. Next, it investigates the historical role of one chieftain named Tiger who, urging forest nomads to settle down and farm, was instrumental in the emergence of a new ethnocultural cluster's identity, and it explores the modalities of the myth-generating conflation of historical elements with religious beliefs. Finally, it scrutinizes the tiger's complex relationship with the moon and thunder, hinting at the pre-existence among former nomads of non-dualistic beliefs in a 'tiger-moon-thunder' set of deities and, touching briefly on the 'thunder complex' question, it stresses ambiguity and variability, reflecting the systemic cultural plasticity and singular cultural histories of these societies. Due to the study's broad spectrum, a large reference list is appended.

CAMBODIA

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATIONS

Debonne, N., van Vliet, J., Verburg, P., et al. (2019). Future governance options for large-scale land acquisition in Cambodia: Impacts on tree cover and tiger landscapes. Environmental Science and Policy, 94, 9-19. *https://doi.org/10.1016/j.envsci.2018.12.031*.

ABSTRACT

This paper investigates how large-scale land acquisitions (LSLAs) can be governed to avoid underuse and thereby spare room for other land claims, specifically nature conservation. LSLA underuse occurs when land in LSLAs is not converted to its intended use. Taking Cambodia as a case, we map converted and unconverted areas within LSLAs using remote sensing. We develop three scenarios of alternative LSLA policies until 2040, and use a land system change model to evaluate how governing the underuse of LSLAs affects overall land use. Specifically, we evaluate the impact of these policies on future tree cover, the size and spatial integrity of natural areas, and the potential these natural areas can offer to meet the conservation target of a successful tiger reintroduction. In 2015, only 32% of LSLA area was converted. Simulations suggest that both interventionist (reclaim unconverted areas) and preventive (avoid non-conversion) policies dramatically reduce underuse. Interventionist policies perform best in limiting tree cover loss and in preserving natural areas, but preventive measures lead to significantly less fragmentation. Noninterventionist policies (no enforced policies) make tiger reintroduction in the Eastern Plains impossible. Preventive policies with well-enforced protected areas succeed in creating the largest potential for tiger reintroduction. Our results suggest that Cambodia can reconcile LSLAs with tiger reintroduction in the Eastern Plains only when using preventive land use policies. In the absence of such policies, tiger survival in the Eastern Plains is unlikely and only the Cardamom or Virachey forest may offer such potential.

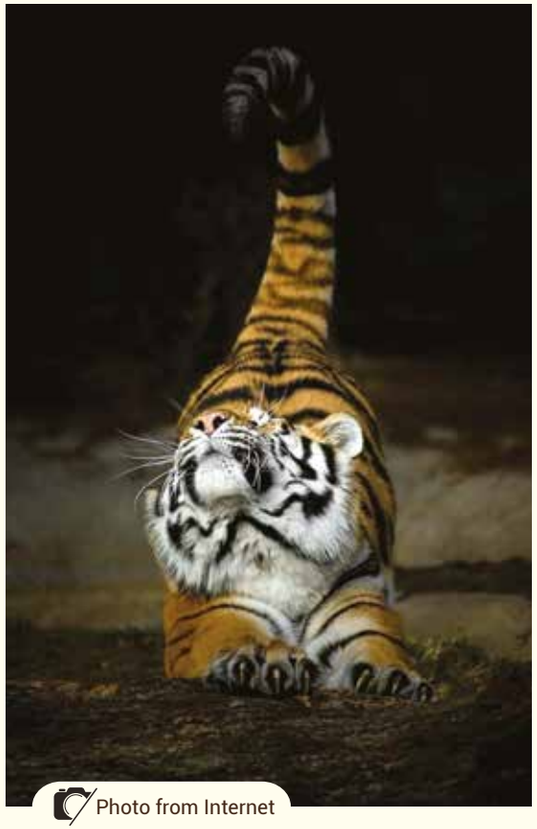


Photo from Internet

CHINA

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Behaviour

Wang, Q., Liu, D., Holyoak, M., Jia, T., Yang, S., Liu, X., Kong, X., and Jiang, G. (2019). Innate preference for native prey and personality implications in captive Amur tigers. Applied Animal Behaviour Science, 210, 95-102.
https://doi.org/10.1016/j.applanim.2018.10.006.

ABSTRACT

Prey recognition is vital for predation and the survival of carnivores. In theory, carnivores recognize prey by instinct or learning. However, the instinct hypothesis has little support. In addition, it remains unknown if prey recognition capability correlates with personality. Here, we test if Amur (or Siberian) tigers (Panthera tigris altaica), an endangered species, instinctually recognize their native prey. By studying both captive and prey-naive Amur tigers, we found that they preferentially responded to the images, sounds and faeces of native prey over those of non-native prey. Further, they showed the strongest preference for images and sounds of the wild boar, the most preferred native prey of wild Amur tigers. The innate olfactory, not visual and auditory, preference for native prey had a significant negative correlation with tiger age. Furthermore, we found that innate prey recognition capability was significantly correlated with the personality traits of tigers. In general, this study indicated that Amur tigers recognize native prey instinctually and this instinct could be identified by personality assessment, providing a potential method to preliminarily screen tiger individuals with keen prey recognition instinct for breeding and wild training.

Photo from Internet

Ecology

Ning, Y., Kostyria, A. V., Ma, J., Chayka, M. I., Guskov, V. Y., Qi, J., Sheremetyeva, I. N., Wang, M., and Jiang, G. (2019). Dispersal of Amur tiger from spatial distribution and genetics within the eastern Changbai mountain of China. Ecology and Evolution, 9(5), 2415-2424. DOI: 10.1002/ece3.4832.

ABSTRACT

Population dispersal and migration often indicate an expanded habitat and reduced inbreeding probability, and to some extend reflects improvement in the condition of the population. The Amur tiger population in the northern region of the Changbai mountain in China mostly distributes along the Sino–Russian border, next to the population in southwest Primorye in Russia. The successful dispersal westward and transboundary movement are crucial for the persistence of the Amur tiger in this area. This study explored the spatial dispersal of the population, transboundary migration, and the genetic condition of the Amur tiger population within the northern Changbai mountain in China, using occurrence data and fecal samples. Our results from 2003 to 2016 showed that the Amur tiger population in this area was spreading westward at a speed of 12.83 ± 4.41 km every three years. Genetic diversity of the Amur tiger populations in southwest Primorye was slightly different than the population in our study area, and the potential individual migration rate between these two populations was shown to be about 13.04%. Furthermore, the relationships between genetic distances and spatial distances indicated the existence of serious limitations to the dispersal of the Amur tiger in China. This study provided important information about spatial dispersal, transboundary migration, and the genetic diversity of Amur tigers in China, showed the urgent need for Amur tiger habitat restoration, and suggested some important conservation measures, such as corridor construction to eliminate dispersal barriers and joint international conservation to promote trans-boundary movement.

Wang, L., Yang, L., Sai, J., Wei, J., Huang, C., Li, D., Zhu, X., Wang, T., Feng, L., and Ge, J. (2019). The quantity and quality of understory forages of the ungulates' habitat in the eastern part of Northeast Tiger and Leopard National, Acta Theriologica Sinica, 39(4), 373-385.

ABSTRACT

Amur tiger (Panthera tigris altaica) and Amur leopard (P. pardus orientalis), the flagship species of the ecosystems, mainly prey on red deer (Cervus elaphus), sika deer (C. nippon), roe deer (Capreolus pygargus), and wild boar (Sus scrofa) in the national park region, while the ungulates rely on forest understory plants. All form the major parts of the grazing food chains in the temperate forest ecosystem of Northeast Asia. The main objective of this study is to comprehend the understory plant resource of the area, and establish baseline data through a vast investigation of the forest vegetation in the eastern part of the national park, in order

to facilitate the estimation of the carrying capacity of the system in supporting the prey populations. In the growing seasons of 2015 and 2016, 141 sample locations associated with the established camera-trap platforms.were randomly selected The 496 transects were nested with the sampling locations, and 1948 sampling plots further nested with the transects. In this nested sampling system, understory biomass, plant group (tender twigs/leaves, grasses/sedges, forbs, and ferns) compositions were investigated, and nitrogen and carbon contents of plant groups were tested. We found that, (1) Forest canopy closure influences the light availability of the understory vegetation, and its productivity and plant group composition. The understory biomass at the open sites was 3 times of that under the closed canopies (94.91 g/m2 vs. 30.15 g/m2, P<0.01). (2) At the open sites, understory biomass was the highest at riparian areas, At the gaps, tender twigs/leaves mainly dominated, while at forest edges, forbs did so, and along the riparian area, mainly sedges. (3) The understory tender twigs/leaves and forbs had the highest N contents, forbs had the lowest C contents and therefore the lowest C/N ratios. The forbs and the tender twigs/leaves should be the better forages for the ungulates. (4) The calorific values of all four understory plant groups were above 17kJ/g with the forbs the lowest. (5) Based on the data, high understory biomass (>40 g/m2) plots dominated by the tender twigs/leaves and forbs were about 16 % of the close canopy plots and 50 % of the open site plots, which could be the hot forage sites for browsers. With the study results, we suggest to maintain some open habitats, as the supplement highly quantity and quality forage patch for wild ungulate i.e. sika deer, to boost their populations for facilitating restoration of the tiger and leopard.

Yang, H., Han, S., Xie, B., Mou, P., Kou, X., Wang, T., Ge, J., and Feng, L. (2019). Do prey availability, human disturbance and habitat structure drive the daily activity patterns of Amur tigers (Panthera tigris altaica)? Journal of Zoology, 307(2), 131-140.

ABSTRACT

The daily activities of animals are influenced by various factors, including their physiological adaptations and preferred habitat distributions, as well as prey availability and human disturbances. For felids, the main drivers of activity patterns appear to be prey availability and anthropogenic disturbances, as suggested by previous studies. In this study, we explore a set of variables that influence the activity patterns of Amur tigers (Panthera tigris altaica) in Jilin and Heilongjiang Provinces in north-east China near south-western Primorsky Krai, Russia. This area is currently the only occupied tiger habitat in China. Prey availability (e.g. wild boar, sika deer and roe deer), human disturbances (e.g. human activity, distance to human settlements and intense forest livestock grazing), and habitat structure were analysed. Our results revealed crepuscular and nocturnal activity of Amur tigers. Although the temporal overlaps between the tigers and their prey species were high, the spatial overlap indices were low. Although the presence of tigers decreased near human settlements, tigers showed a preference for walking along roads. Tigers also avoided high-elevation coniferous and mixed hardwood forests. Overall, our results indicated that (1) tigers spatially and temporally avoided human disturbances

and tigers respond behaviourally to human disturbances and (2) human disturbances may determine the activity of Amur tigers in north-east China. In the future, to address conflicts between tigers and local humans and to improve tiger conservation, conservation planning should incorporate the spatio-temporal activity patterns of tigers and humans.

GENETICS

Zhang, W., Xu, X., Yue, B., Hou, R., Xie, J., Zou, Z. T., Han, Y., Shen, F., Zhang, L., Xie, Z., Yuan, Y., Yin, Y., Fu, W., Chen, D., Huang, W., Liu, Z., Tang, Y., Zhao, B., Zhang, Q., Chen, W., Zhang, Z. (2019). Sorting Out the Genetic Background of the Last Surviving South China Tigers. The Journal of Heredity, 110(6), 641–650.
https://doi.org/10.1093/jhered/esz034.

ABSTRACT

The South China tiger (Panthera tigris amoyensis) is endemic to China and also the most critically endangered subspecies of living tigers. It is considered extinct in the wild and only about 150 individuals survive in captivity to date, whose genetic heritage, however, is ambiguous and controversial. Here, we conducted an explicit genetic assessment of 92 studbook-registered South China tigers from 14 captive facilities using a subspecies-diagnostic system in the context of comparison with other voucher specimens to evaluate the genetic ancestry and level of distinctiveness of the last surviving P. t. amoyensis. Three mtDNA haplotypes were identified from South China tigers sampled in this study, including a unique P. t. amoyensis AMO1 haplotype not found in other subspecies, a COR1 haplotype that is widespread in Indochinese tigers (P. t. corbetti), and an ALT haplotype that is characteristic of Amur tigers (P. t. altaica). Bayesian STRUCTURE analysis and parentage verification confirmed the verified subspecies ancestry (VSA) as the South China tiger in 74 individuals. Genetic introgression from other tigers was detected in 18 tigers, and subsequent exclusion of these and their offspring from the breeding program is recommended. Both STRUCTURE clustering and microsatellite-based phylogenetic analyses demonstrated a close genetic association of the VSA South China tigers to Indochinese tigers, an issue that could only be elucidated by analysis of historical South China tiger specimens with wild origin. Our results also indicated a moderate level of genetic diversity in the captive South China tiger population, suggesting a potential for genetic restoration.

MONITORING AND ASSESSMENT

Shuyuan Li, Jianguo Li, Hanlin Tang, Rui Qian, Weiyao Lin. (2019). A Benchmark for Amur Tiger Re-identification in the Wild. MM '20: Proceedings of the 28th ACM International Conference on Multimedia. Pages 2590–2598. *https://doi.org/10.1145/3394171.3413569*.

ABSTRACT

Monitoring the population and movements of endangered species is an important task to wildlife conversation. Traditional tagging methods do not scale to large populations, while applying computer vision methods to camera sensor data requires re-identification (re- ID) algorithms to obtain accurate counts and moving trajectory of wildlife. However, existing re-ID methods are largely targeted at persons and cars, which have limited pose variations and constrained capture environments. This paper tries to fill the gap by introducing a novel large-scale dataset, the Amur Tiger Re-identification in the Wild (ATRW) dataset. ATRW contains over 8,000 video clips from 92 Amur tigers, with bounding box, pose keypoint, and tiger identity annotations. In contrast to typical re-ID datasets, the tigers are captured in a diverse set of unconstrained poses and lighting conditions. We demonstrate with a set of baseline algorithms that ATRW is a challenging dataset for re-ID. Lastly, we propose a novel method for tiger re-identification, which introduces precise pose parts modeling in deep neural networks to handle large pose variation of tigers, and reaches notable performance improvement over existing re-ID methods. The ATRW dataset is public available at *https://cvwc2019.github.io/challenge.html*.

Zhu, S., Qu, Y., Liu, Y., Dobrynin, D. V., Sukhova, O. V., Kotlov, I. P., Sandlersky, R. B., Yachmennikova, A. A., and Rozhnov, V. V. (2019). The structure of the amur tiger (panthera tigris altaica) potential habitats and evaluation of its prey in the Taipingou national park (China) based on remote sensing data. Исследования Земли из Космоса, (4), 60-86. doi: 10.31857/S0205-96142019460-86.

ABSTRACT

The population of the Amur tiger (Panthera tigris altaica) in the Russian Far East is currently being restored; young individuals are being spread within the historical range, including territory in China. Here, the assessment of the suitability for the territories that exist in Northeastern China as the Amur tiger habitat and its food supply/prey base (three species of ungulates, namely wild boar, red deer and roe deer) are shown. A specially protected area—the Taipingou National Park, located on the border of the People's Republic of China and Russia—was examined. The modelling of habitat suitability for ungulates was performed on the basis of Earth remote sensing data by using two different approaches: expert geo-information assessment of the

territory and discriminant analysis modelling. Based on discriminant analysis, the modelling of the suitability of ungulate habitats (without the variability of plant communities) showed a small difference between the model results for wild boar and roe deer. Nevertheless, the connection with the morphometric characteristics of the relief was more important for the wild boar than the roe deer. Furthermore, the variability of vegetation types was more important for the roe deer. The analysis of the biotopes showed that wild boars prefer the central and northern parts of Taipingou National Park, while the main roe deer distribution.

SUSTAINABLE SOLUTION AND TECHNOLOGY

Liu, C., Zhang, R., and Guo, L. (2019). Part-Pose Guided Amur Tiger Re-Identification. In IEEE/CVF International Conference on Computer Vision Workshop (ICCVW), Seoul, Korea (South), pp. 315-322. DOI: 10.1109/ICCVW.2019.00042.

ABSTRACT

In this paper, we present our solution to tiger re-identification (re-ID) in both the plain and the wild tracks in the 2019 Computer Vision for Wild life Conservation Challenge (CVWC2019). We introduce a novel part-pose guided framework for the tiger re-ID task, which consists of two part streams and one full stream based on the pose characteristics of tiger. Considering missing and inaccurate pose annotations, the two part streams are used as a regulator to guide the full stream in learning and aligning the local features in the training stage. We only use the learnt full stream for the tiger re-ID task in the inference stage. The proposed model has the advantage that despite requiring pose information at training time it is not needed during inference, so it is particularly suitable for tiger re-ID in the wild. Our proposed method outperforms the state-of-the-art and finished top in both the PlainID and WildID competitions at CVWC2019. The source of code will be public available at *https://github.com/LcenArthas/CVWC2019-Amur-Tiger-Re-ID*.

Dhritiman Mukherjee

Yu, J., Su, H., Liu, J., Yang, Z., Zhang, Z., Zhu, Y., Yang, L., and Jiao, B. (2019). A Strong Baseline for Tiger Re-ID and its Bag of Tricks. IEEE/CVF International Conference on Computer Vision Workshop (ICCVW). DOI: 10.1109/ICCVW.2019.00040.

ABSTRACT

As an instance-level recognition task, person re-identification methods always calculate local features by horizontal pooling. It is based on a simple assumption that pedestrians always stand vertically. But as to wildlife re-identification task, we can not make similar assumption since the various view-angles of wildlife. In this paper, we propose a novel dynamic partial matching method. In our module, global feature learning benefits greatly from local feature learning, which performs an alignment/matching by flipping local features and calculating the shortest path between them. Besides the partial matching method, we also consider a series of data augmentation methods such as flip as new id, random whitening, random crop and so on. And we also use an example sampling strategy, i.e., hard negative mining, for training. In addition, we ensemble the models with different backbones and epochs using imagenet pre-trained models. Extensive experiments validate the superiority of our method for tiger Re-ID. Code has been released at *https://github.com/vvictoryuki/tiger_reid_pytorch*.

ZOOLOGY AND ANIMAL WELFARE

Yang, Y., Dong, H., Su, R., Jiang, N., Li, T., Su, C., Yuan, Z., and Zhang, L. (2019). Direct evidence of an extra-intestinal cycle of Toxoplasma gondii in tigers (Panthera tigris) by isolation of viable strains. Emerging Microbes and Infections, 8(1), 1550-1552. DOI: 10.1080/22221751.2019.168247.

ABSTRACT

Toxoplasmosis is one of the most common zoonotic diseases in the world. Felines excrete environmentally resistant Toxoplasma gondii oocysts. However, there is no direct evidence to prove tigers are the intermediate host of T. gondii. Here, we show that, IgG antibodies to T. gondii in 80% (8/10) of captive tigers. Two viable T. gondii strains (ToxoDB genotype #9) were isolated by bioassay in mice using striated muscles of two tigers (Tiger#3 and Tiger#8). Additionally, mice were confirmed as T. gondii-positive by bioassay of feces #89–110, but no viable T. gondii strain was isolated successfully. The fecal samples from tigers may contain T. gondii oocysts. This is the first report of T. gondii isolation from tigers. These results provide direct evidence that an extra-intestinal cycle of T. gondii may develop in tigers.

Zhang, H. H., Qiu, Q. G., Liu, S. J., et al. (2019). Genomic characterization of a novel astrovirus identified in Amur tigers from a zoo in China. Archives of Virology, 164(11), 3151–3155. DOI: 10.1007/s00705-019-04435-2.

ABSTRACT

Astroviruses (AstVs) have a very wide range of hosts and are associated with enteric and extra-enteric disease in mammals and birds. Cross-species transmission of AstVs has been observed frequently. In the present study, the genome of a novel astrovirus from Amur tigers (Panthera tigris) from a zoo in China was characterized and was found to have the typical genomic features of other mammal AstVs. It showed the highest nucleotide sequence similarity (46.1-87.3% identity) to AstVs from cats, indicating a close phylogenetic relationship and possible cross-species transmission between them. To our knowledge, this is the first identification and characterization of AstV from tigers, and this virus is the third astrovirus identified in hosts of the family Felidae. The results of this study will be helpful for understanding the origin, genetic diversity, and cross-species transmission of AstV.

Wang, K., Du, S., Wang, Y., Wang, S., Luo, X., Zhang, Y., Liu, C., Wang, H., Pei, Z., and Hu, G. (2019). Isolation and identification of tiger parvovirus in captive siberian tigers and phylogenetic analysis of VP2 gene. Infection, Genetics and Evolution: Journal Of Molecular Epidemiology And Evolutionary Genetics In Infectious Diseases, 75, 103957. *https://doi.org/10.1016/j.meegid.2019.103957*

ABSTRACT

To better understand the prevalence and molecular epidemiology of parvovirus, this study reports the isolation and characterization of a tiger parvovirus (TPV) named CHJL-Siberian Tiger-01/2017 from a captive Siberian tiger in Jilin Province, China. A phylogenetic tree based on the full-length VP2 nucleotide sequence was constructed using the isolated strain in this study and 56 reference strains. The results showed that all the parvoviruses can be grouped into two large branches: the canine parvovirus (CPV) branch and the feline parvovirus (FPV) branch. FPV strains comprised TPVs, FPVs, blue fox parvoviruses (BFPVs), mink enteritis viruses (MEVs), and raccoon feline parvoviruses (RFPVs), and CPV strains comprised CPVs and raccoon dog parvoviruses (RDPVs). RFPVs are also often very closely related to those sampled from other carnivorous species, and raccoons may represent conduits for parvovirus transmission to other hosts. The results of amino acid changes in the VP2 protein of the isolated strain showed that amino acid Ile 101 was mutated to Thr (I 101T). Taken together, a field TPV strain CHJL-Siberian Tiger-01/2017 was isolated, which may be suitable for future studies on FPV infection, replication and vaccine development. This study provided new important findings about the evolution of parvovirus infection in tigers.

GLOBAL

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Adrian, B. (2019). Tiger Talk. Front Ecol Environ; 17(1): 68–68, doi:10.1002/fee.1998.

ABSTRACT

Roaring, growling, snarling, snorting – fine. But why would a tiger (Panthera tigris) make a sound like a frightened sambar deer (Rusa unicolor)?
(compare recordings at *https://bit.ly/2CVLJiu and https://bit.ly/2H1gbMm*). It's not the kind of thing you would expect from a tiger, yet this "pooking" call, as it is known, has regularly popped up in the literature as being made by Bengal tigers (Figure 1) for over 100 years. Following the investigations of renowned naturalist George Schaller, it became generally accepted that tigers pook to warn other tigers (and possibly even humans) of their presence, and thus avoid unexpected encounters (Schaller G. 1967. The Deer and the Tiger, A Study of Wildlife in India. Chicago, IL: University of Chicago Press). Alternatively, some suggest it may be a location call, perhaps between mates. Hunters in India, however, have long held that tigers pook to attract sambar deer. Crazy, right? Well, I thought so too, until I discovered that margays (Leopardus wiedii), small cats found in Central and South America, get up to similar antics.

Anatomy

Encinoso M, Orós J, Ramírez G, Jaber JR, Artiles A, Arencibia A. (2019). Anatomic Study of the Elbow Joint in a Bengal Tiger (Panthera tigris tigris) Using Magnetic Resonance Imaging and Gross Dissections. Animals (Basel), 1;9(12):1058. doi: 10.3390/ani9121058. PMID: 31805734; PMCID: PMC6940883.

ABSTRACT

The objective of our research was to describe the normal appearance of the bony and soft tissue structures of the elbow joint in a cadaver of a male mature Bengal tiger (Panthera tigris tigris) scanned via MRI. Using a 0.2 Tesla magnet, Spin-echo (SE) T1-weighting, and Gradient-echo short tau inversion recovery (GE-STIR), T2-weighting pulse sequences were selected to generate sagittal, transverse, and dorsal planes. In addition, gross dissections of the forelimb and its elbow joint were made. On anatomic dissections, all bony, articular, and muscular structures could be identified. The MRI images allowed us to observe the bony and many soft tissues of the tiger elbow joint. The SE T1-weighted MR images provided good anatomic detail

of this joint, whereas the GE-STIR T2-weighted MR pulse sequence was best for synovial cavities. Detailed information is provided that may be used as initial anatomic reference for interpretation of MR images of the Bengal tiger (Panthera tigris tigris) elbow joint and in the diagnosis of disorders of this region.

Behaviour

Stryker, J. A., Atkinson, J. L., Brown, R. D., Barney, D., Robinson, J. A. B., Duncan, J., and Finegan, E. J. (2019). Behavioral repertoire assessment of Bengal tigers (Panthera tigris) with focus on thermoregulatory behavior. International journal of biometeorology, 63(10), 1369–1379. *https://doi.org/10.1007/s00484-019-01753-7*.

ABSTRACT

The behavioral repertoire and environmental feature needs for thermoregulatory comfort have not been reported in the literature for large captive exotics. An observational study was done to investigate the behavioral repertoire of tigers via continuous observation, while focusing on thermoregulatory behavior, in order to examine behavioral and thermoregulatory needs of these animals, and inform microclimatic landscape design for thermal comfort. Nine Bengal tigers (n = 6 females, n = 3 males) were observed in June 2012, and behavior data were recorded every minute, while thermal images of each individual, wind speed, ambient temperature, and relative humidity were recorded every 15 min. Descriptive statistics were used to analyze the data due to the observatory nature of the study. All tigers spent on average over 45% of the time lying down, less than 19% of the time in direct sunlight and over 20% of their time in the shade. Males did more panting (25.6%) than females (15.1%). There was more individual variation in water and cave usage, compared with shade use and lying behaviors, which could be related to social pressures or basic individual preferences. In summary, shade is a very valuable thermoregulatory resource for tigers. Adding more shade structures to increase thermal comfort and increase activity in these cats (around 10%on average active behaviors) by adding to the space available in the shaded areas.

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATIONS

Campbell, K., Martyr, D., Risdianto, D., and Clemente, C. J. (2019). Two species, one snare: Analysing snare usage and the impacts of tiger poaching on a non-target species, the Malayan tapir. Biological Conservation, 231, 161-166. DOI: 10.1016/j.biocon.2019.01.009.

ABSTRACT

The illegal trade in tiger bones and body parts is crippling the remaining populations of tigers worldwide, but what effect does this trade have on other wildlife that get caught in the cross fire? The Malayan tapir (Tapirus indicus) is the only species of tapir found outside of South America, yet little is known of this subspecies despite its large size. Aside from habitat loss and an encroaching human population, effects of wildlife trade are taking their toll on this endangered species. In Sumatra Indonesia, tigers and tapirs are known to share habitat, potentially leaving tapirs vulnerable to fall victim to snare entrapment. This study looks at correlations between tiger and tapir indices as well as active tiger snares within Kerinci Seblat National Park, Sumatra, Indonesia over a four-year period. Data was provided by the Indonesian Ministry of Environment and Forestry and Fauna and Flora International, and this study investigated the frequency, and spatial relationships between all three variables. Across the study period, tiger snares increased significantly in numbers and spatial extent, indicating increased illegal poaching in KSNP. Areas with high frequencies of tiger evidence also showed high frequencies of tapir evidence, but while tiger frequency remained consistent, tapirs displayed a decreasing trend. Spatially, tiger evidence moved further away from snare and tapir locations over time, indicating tigers, (while being the target species) may display a greater response to poaching threats than tapirs. Tapir mortality was significantly correlated with the number of snares per kilometre surveyed, further supporting a negative impact from snares on tapirs. This study recommends long-term analysis to accurately determine the current population of Malayan tapirs in Sumatra and identify population trends. Identifying Sumatra's tapir population and recovery in response to poaching and habitat loss threats, must be determined to accurately inform conservation management actions of Sumatra's National Parks, and halt the decline of this illusive species.

Luo, S. J., Liu, Y. C., and Xu, X. (2019). Tigers of the World: Genomics and Conservation. Annual Review of Animal Biosciences, 7, 521–548. *https://doi.org/10.1146/annurev-animal-020518-115106*.

ABSTRACT

Of all the big cats, or perhaps of all the endangered wildlife, the tiger may be both the most charismatic and most well-recognized flagship species in the world. The rapidly changing field of molecular genetics, particularly advances in genome sequencing technologies, has provided new tools to reconstruct what characterizes a tiger. Here we review how applications of molecular genomic tools have been used to depict the tiger's ancestral roots, phylogenetic hierarchy, demographic history, morphological diversity, and genetic patterns of diversification on both temporal and geographical scales. Tiger conservation, stabilization, and management are important areas that benefit from use of these genome resources for developing survival strategies for this charismatic megafauna both in situ and ex situ.

Sanderson, E. W., Moy, J., Rose, C., Fisher, K., Jones, B., Balk, D., Clyne, P., Miquelle, D., and Walston, J. (2019). Implications of the shared socioeconomic pathways for tiger (Panthera tigris) conservation. Biological Conservation, 231, 13-23. DOI: 10.1016/j.biocon.2018.12.017.

ABSTRACT

Over the last century, numbers of wild tigers (Panthera tigris) have crashed, while human populations have boomed. Here we investigate future trajectories of human population within tiger range through analysis of the shared socio-economic pathways (SSPs). These five pathways describe urban, rural and total population distributions by decade through 2100, based on plausible but contrasting scenarios of economic, education, migration, and urbanization policy. In 2010 approximately 57 million people lived in regions defined as "tiger conservation landscapes" (or TCLs); 8% of sympatric people lived in towns and cities that occupied 4% of tiger range. We show that tigers could share these same geographies with as few as 40 million (30% decline compared to 2010) or as many as 106 million people (an increase of 85%) by 2100. Those populations could be as much as 64%, or as little as 17%, urbanized, depending on the pathway. Urban areas are likely to expand, displacing between 6 and 22% of tiger's current range, depending on how urban growth is managed. Human population density thresholds compatible with tigers vary by region, from 140 persons/km^2 in the Indian subcontinent, to 10 persons/km^2 in the Russian Far East and northern China. SSP3, a future where nations indulge regional rivalries, would make conservation more difficult, whereas SSP1, with a focus on well-managed urbanization and education, could help relieve pressures. Tigers are a conservation-reliant species and will likely remain so through the 21st century, therefore we suggest coupling continued site-level protection with efforts to develop constituencies for conservation in Asia's burgeoning cities.

ZOOLOGY AND ANIMAL WELFARE

Arencibia, A., Matos, J., Encinoso, M., Gil, F., Artiles, A., Martínez-Gomariz, F., and Vázquez, J. M. (2019). Computed tomography and magnetic resonance imaging study of a normal tarsal joint in a Bengal tiger (Panthera tigris). BMC Veterinary Research, 15(1), 126. *https://doi.org/10.1186/s12917-019-1865-1*.

ABSTRACT

Background: In this research, using computed tomography (CT) and magnetic resonance imaging (MRI), we provide a thorough description of the standard appearance of a right tarsal joint in a Bengal tiger (Panthera tigris). CT scans were performed using a bone and soft tissue window setting, and three-dimensional surface reconstructed CT images were obtained. The MRI protocol was based on the use of Spin-echo (SE) T1-weighted and Gradient-echo (GE) STIR T2-weighted pulse sequences. Magnetic resonance (MR) images were taken in the transverse, sagittal and dorsal planes. We also performed anatomical dissections to facilitate the interpretation of the different structures of the tarsus joint and allow comparisons with CT and MRI images.

Results: The CT images allowed us to observe differences between the bones and soft tissues of the tarsal joint. When applying the bone window setting, the obtained footage showed the anatomy between the medulla and cortex. Additionally, the trabecular bone was delineated. By contrast, the soft tissue window allowed the main soft tissue structures of the tarsal joint, including ligaments, muscles and tendons, to be differentiated. Footage of the main anatomical structures of the standard tiger tarsus was obtained through MRI. The SE T1-weighted images showed the best evaluation of the cortical, subchondral and trabecular bone of the tibia, fibula, tarsus and metatarsus bones. Nonetheless, the GE STIR T2-weighted images allowed us to better visualize the articular cartilage and synovial fluid. In both MRI pulse sequences, the ligaments and tendons appeared with low signal intensity compared with muscles that were visible with intermediate signal intensity.

Conclusions: The results of this CT and MRI study of the Bengal tiger tarsal joint provide some valuable anatomical information and may be useful for diagnosing disorders in this large non-domestic cat.

Boudreaux, B. B., LaRue, S. M., Rademacher, N., Neck, D., Grasperge, B., Wood, C., and Baker, D. G. (2019). Treatment of leiomyosarcoma in a tiger (Panthera tigris) with stereotactic radiotherapy. Veterinary radiology and ultrasound: the official journal of the American College of Veterinary Radiology and the International Veterinary Radiology Association, 60(3), E33–E37. *https://doi.org/10.1111/vru.12720*.

ABSTRACT

A 10-year-old male captive tiger (Panthera tigris) developed right-sided facial asymmetry and enlargement. Computed tomography revealed a destructive mass of the right maxillary bone with right nasal cavity involvement. Histopathology indicated a spindle cell sarcoma. A single fraction of 22 Gy using stereotactic radiotherapy was prescribed. After treatment, the facial conformation returned to normal and the tiger resumed normal behavior. Diagnostics 4 months later indicated severe metastatic disease. Humane euthanasia and necropsywere performed. This is the first case utilizing stereotactic radiotherapy for the treatment of cancer in a tiger.

Capasso, M., Girolamo, N. D., Silvestre, P., and Laricchiuta, P. (2019). Performance of two portable blood glucose meters for measuring blood glucose concentration in tigers (Panthera tigris) and lions (Panthera leo). Journal of the American Veterinary Medical Association, 254(3), 399–408. *https://doi.org/10.2460/javma.254.3.399*.

ABSTRACT

To investigate the performance of a portable blood glucose meter (PBGM) designed for use in humans (hPBGM) and a PBGM designed for use in dogs and cats (vPBGM) when measuring blood glucose (BG) concentration in tigers (Panthera tigris) and lions (Panthera leo). DESIGN Method comparison and diagnostic accuracy study. SAMPLES 53 blood samples from tigers (n = 27) and lions (26). PROCEDURES BG concentration was measured with 2 identical hPBGMs, 2 identical vPBGMs, and a reference laboratory analyzer. Bland-Altman bias plots and Passing-Bablok regression analysis were used to assess agreement. Sensitivity, specificity, and positive and negative predictive values with corresponding 95% confidence intervals were calculated for use in assessing diagnostic accuracy of the investigated PBGMs. RESULTS Bias (95% limits of agreement) was -4.3 mg/dL (-46.3 to 37.6 mg/dL) for the hPBGM, -9.3 mg/dL (-64.6 to 46.0 mg/dL) for the vPBGM on canine setting, and 2.3 mg/dL (-47.9 to 52.6 mg/dL) for the vPBGM on feline setting. The hPBGM had better overall repeatability (coefficient of variation, 3.73%) than the vPBGM on canine (9.29%) or feline (9.44%) setting. Total error for the hPBGM, vPBGM on canine setting, and vPBGM on feline setting was 11.8%, 27.7%, and 20.9%, respectively. None of the PBGMs complied with the maximum allowable total error suggested by current guidelines when measuring BG in tigers and lions with hypo-, normo-, or hyperglycemia. CONCLUSIONS

AND CLINICAL RELEVANCE Results indicated that the PBGMs evaluated were inadequate for measuring BG concentration in tigers and lions.

Cushing, A. C., Ramsay, E. C., Newman, S. J., Hespel, A. M., and Sula, M. M. (2019). Hypergammaglobulinemia And Myeloma in Five Tigers (Panthera Tigris): Clinicopathological Findings. Journal Of Zoo and Wildlife Medicine, 50(1), 219–224. *https://doi.org/10.1638/2018-0068*.

ABSTRACT

Five adult tigers (Panthera tigris) presented with a range of clinical signs, including paresis (2/5), lameness (2/5), ataxia (3/5), anorexia (5/5), and lethargy (5/5). Each tiger demonstrated elevated plasma globulin levels (7.8–14.8 g/dl; [reference interval 2–5.1 g/dl]) on routine biochemistry, confirmed as a monoclonal gammopathy using protein electrophoresis. Serum gammaglobulin concentration ranged from 5 to 7.5 g/dl, or 45.1–63.4% of total protein concentration. Azotemia was present in three tigers. Diagnostics and management varied with the presenting signs but included magnetic resonance imaging, radiography, chemotherapy, supportive care, and euthanasia. In each case, necropsy revealed a neoplastic plasma cell proliferation in the bone marrow and one or more extramedullary sites. Lytic lesions in the thoraco-lumbar spine were found in three animals, and one lesion was associated with spinal cord compression. Splenomegaly was present in 4/5 cases. Histopathology confirmed a plasma cell neoplasm in each case, and immunohistochemistry staining with multiple myeloma oncogene 1 (MUM1) was positive in each case. CD20 staining was performed in two cases and was positive in one. CD3 staining was performed in the same two cases, and was negative in each. Based on the clinical, gross, microscopic, and immunohistochemical findings, myeloma was diagnosed in all five tigers.

Hanshaw, D. M., McLelland, D. J., Manavis, J., and Finnie, J. W. (2019). Large felid leucoencephalomyelopathy in a Sumatran tiger (Panthera tigris sumatrae) from an Australian zoo. Australian veterinary journal, 97(8), 277–282. *https://doi.org/10.1111/avj.12826*.

ABSTRACT

Five adult tigers (Panthera tigris) presented with a range of clinical signs, including paresis (2/5), lameness (2/5), ataxia (3/5), anorexia (5/5), and lethargy (5/5). Each tiger demonstrated elevated plasma globulin levels (7.8–14.8 g/dl; [reference interval 2–5.1 g/dl]) on routine biochemistry, confirmed as a monoclonal gammopathy using protein electrophoresis. Serum gammaglobulin concentration ranged from 5 to 7.5 g/dl, or 45.1–63.4% of total protein concentration. Azotemia was present in three tigers. Diagnostics and management varied with

the presenting signs but included magnetic resonance imaging, radiography, chemotherapy, supportive care, and euthanasia. In each case, necropsy revealed a neoplastic plasma cell proliferation in the bone marrow and one or more extramedullary sites. Lytic lesions in the thoraco-lumbar spine were found in three animals, and one lesion was associated with spinal cord compression. Splenomegaly was present in 4/5 cases. Histopathology confirmed a plasma cell neoplasm in each case, and immunohistochemistry staining with multiple myeloma oncogene 1 (MUM1) was positive in each case. CD20 staining was performed in two cases and was positive in one. CD3 staining was performed in the same two cases, and was negative in each. Based on the clinical, gross, microscopic, and immunohistochemical findings, myeloma was diagnosed in all five tigers.

Hanshaw, D. M., McLelland, D. J., Manavis, J., and Finnie, J. W. (2019). Large felid leucoencephalomyelopathy in a Sumatran tiger (Panthera tigris sumatrae) from an Australian zoo. Australian veterinary journal, 97(8), 277–282. *https://doi.org/10.1111/avj.12826*.

ABSTRACT

Case report: The clinicopathological features of a case consistent with large felid leucoencephalomyelopathy are described in a 19-year-old, zoo-based Sumatran tiger in which degenerative vertebral disease, renal insufficiency, diaphragmatic hernia and cataracts were comorbid. The principal presenting sign was ataxia, with concurrent deterioration of vertebral stiffness and vision loss. Histological features included marked destruction of the white matter, the formation of large, bizarre astrocytes and accumulation of numerous foamy macrophages (gitter cells). Immunohistochemical investigation of reactive astrocytes revealed several different cytoplasmic proteins.

Conclusion: This is the first reported case of large felid leucoencephalomyelopathy in Australia.

Kawata, R., Ii, T., Hori, T., Machida, Y., Ochiai, K., Azakami, D., Ishiwata, T., and Michishita, M. (2019). Leydig cell tumor in an Amur tiger (Panthera tigris altaica). The Journal of veterinary medical science, 81(2), 186–189. *https://doi.org/10.1292/jvms.18-0573*.

ABSTRACT

A 14-year and 8-month-old intact male Amur tiger presented with an enlarged left testis, measuring 5.7 × 5.5 × 4.5 cm. The cut surface was mottled dark red to reddish brown in color. Microscopically, the enlarged left testis comprised round or polygonal neoplastic cells arranged in a diffuse sheet pattern. These neoplastic cells had a hyperchromatic nucleus

and an abundant eosinophilic cytoplasm. Immunohistochemically, these neoplastic cells were positive for vimentin, chromogranin A, synaptophysin, melan-A, inhibin-α, and S100 and negative for desmin and WT-1. Based on these morphological and immunohistochemical findings, the tumor was diagnosed as a Leydig cell tumor.

Law, G. and Kitchener, A.C. (2019), Twenty years of the tiger feeding pole: review and recommendations. Int. Zoo Yb., 54: 174-190. *https://doi.org/10.1111/izy.12249*

ABSTRACT

The tiger feeding pole was developed at Glasgow Zoo, UK, more than 20 years ago as a feeding-enrichment device. Since then, the adoption of the feeding pole by other zoos for Tigers Panthera tigris and other cats has been slow and sporadic until recent years when many zoos in the UK have begun to use this device. In this paper we review the basis for and the development of the feeding pole as a feeding-enrichment tool, including its stimulation of simulated hunting behaviours, and benefits to health and welfare. A survey of 19 zoos (mostly based in the UK) found that 79% use or have used feeding poles usually about once per week at heights of 3–6 m. We know of no confirmed reports of serious injuries or deaths of cats using feeding poles. A comparison of the skeletons of tigers found that feeding-pole-using tigers had a mean arthrosis score that is four times less than that of tigers that did not use them, providing a positive indicator of the health benefit of the use of this enrichment device. Based on previous experience we provide a refined set of recommendations for the safe use of feeding poles for cats, but recognize that providing physical and mental challenges to animals in zoos carries some minor risks that animals are well able to cope with. We discuss the possible next steps in feeding enrichment, which may include a holistic approach that considers the need to manage predators alongside prey to allow for mutual visual and olfactory enrichments.

Sibarani, MC, Di Marco, M, Rondinini, C, Kark, S. (2019) Measuring the surrogacy potential of charismatic megafauna species across taxonomic, phylogenetic and functional diversity on a megadiverse island. J Appl Ecol, 56: 1220–1231. *https://doi.org/10.1111/1365-2664.13360*.

ABSTRACT

Conservation organisations and governments often use charismatic megafauna as surrogates to represent broader biodiversity. While these species are primarily selected as “flagships” for marketing campaigns, it is important to evaluate their surrogacy potential, i.e. the extent to which their protection benefits other biodiversity elements. Four charismatic megafauna species are used as surrogates in the megadiverse island of Sumatra: the Sumatran tiger Panthera tigris sumatrae, Sumatran elephant Elephas maximus sumatranus, Sumatran orangutan Pongo

abelii and Sumatran rhinoceros Dicerorhinus sumatrensis. We examined how well each of these species performed in representing the distribution of all co-occurring terrestrial mammal species on the island, and the priority areas for the conservation of three facets of mammalian biodiversity (taxonomic, phylogenetic and functional). 2. We used habitat suitability models to represent the distribution of 184 terrestrial mammal species, 160 phylogenetic groups and 74 functional trait groups. We then identified priority conservation areas using the spatial prioritisation software Zonation. 3. We found that the habitat overlap between each of the four charismatic species and the other mammal species varied, ranging from a mean of 52% (SD = 27%) for the tiger to 2% (SD = 2%) for the rhino. Combining the four species together improved the representation levels only marginally compared to using the tiger only. Among the four charismatic megafauna species, the extent of suitable habitat of Sumatran tiger covered the highest proportion of priority conservation areas. The Sumatran tiger also outperformed most of other mammal species with similar range sizes. 4. We found that some of the top-ranked conservation areas for taxonomic (28%), phylogenetic (8%) and functional diversity (19%) did not overlap with any of the charismatic species' suitable habitat. 5. Synthesis and applications. Wide-ranging charismatic species can represent broader mammalian biodiversity, but they may miss some key areas with high biodiversity importance. We suggest that a combination of systematic spatial prioritisation and surrogacy analyses are important in order to determine the allocation of conservation resources in biodiversity-rich areas such as Sumatra, where an expansion of the protected area network is required.

Whitten, C., Vogelnest, L., D'Arcy, R., Thomson, P., and Phalen, D. (2019). A Retrospective Study of Reported Disorders of the Oral Cavity in Large Felids in Australian Zoos. Journal of zoo and wildlife medicine, 50(1), 16–22. *https://doi.org/10.1638/2016-0170*.

ABSTRACT

Disorders of the oral cavity are conditions reported by veterinarians that impact the health and welfare of large felids in human care. There have been no studies documenting the prevalence of these conditions and species affected in Australian zoos. A review of the medical records of lions (Panthera leo), tigers (Panthera tigris), cheetahs (Acinonyx jubatus), jaguars (Puma onca), snow leopards (Panthera uncia), Persian leopards (Panthera pardus saxicolor), and cougars (Puma concolor) from 10 Australian zoos and an online survey of zoo professionals from Australian and New Zealand zoos was performed to determine the recorded prevalence of disorders of the oral cavity in these species. Preliminary assessments were also made to determine if there was an association between the occurrence of tooth fractures and diet, feeding practices, species, sex, and age of the animal. The study also examined associations of these conditions with behavior, such as fighting, and husbandry practices, such as the provision of enrichment items. The review found that tooth fractures were common in tigers

and lions greater than 8 yr of age. Animal caregivers attributed this to animals chewing on large, hard pieces of bone in some instances, but this could not be verified. Instances of bones being lodged between canine teeth were observed and appeared to be related to the feeding of bones of inappropriate size. Based on these findings, it is recommended that guidelines for bone size fed be developed and that animals over the age of 8 yr receive regular dental examinations under general anesthesia.

MONITORING AND ASSESSMENT

Al-Naji, A., Tao, Y., Smith, I., and Chahl, J. (2019). A pilot study for estimating the cardiopulmonary signals of diverse exotic animals using a digital camera. Sensors, 19(24), 5445. *https://doi.org/10.3390/s19245445*.

ABSTRACT

Monitoring the cardiopulmonary signal of animals is a challenge for veterinarians inconditions when contact with a conscious animal is inconvenient, di cult, damaging, distressing or dangerous to personnel or the animal subject. In this pilot study, we demonstrate a computer vision-based system and use examples of exotic, untamed species to demonstrate this means to extract the cardiopulmonary signal. Subject animals included the following species: Giant panda (Ailuropoda melanoleuca), African lions (Panthera leo), Sumatran tiger (Panthera tigris sumatrae), koala (Phascolarctos cinereus), red kangaroo (Macropus rufus), alpaca (Vicugna pacos), little blue penguin (Eudyptula minor), Sumatran orangutan (Pongo abelii) and Hamadryas baboon (Papio hamadryas). The study was done without need for restriction, fixation, contact or disruption of the daily routine of the subjects. The pilot system extracts the signal from the abdominal-thoracic region, where cardiopulmonary activity is most likely to be visible using image sequences captured by a digital camera. The results show motion on the body surface of the subjects that is characteristic of cardiopulmonary activity and is likely to be useful to estimate physiological parameters (pulse rate and breathing rate) of animals without any physical contact. The results of the study suggest that a fully controlled study against conventional physiological monitoring equipment is ethically warranted, which may lead to a novel approach to non-contact physiological monitoring and remotely sensed health assessment of animals. The method shows promise for applications in veterinary practice, conservation and game management, animal welfare and zoological and behavioral studies.

Hariyanto, E., Iqbal, M., Siahaan, A. P. U., Saragih, K. S., and Batubara, S. (2019). Comparative study of tiger identification using template matching approach based on edge patterns. Journal of Physics: Conference Series, 1196, 012025.

ABSTRACT

The presence of tigers in residential areas as predators was a threat to humans and their livestock. Through digital image processing, these animals could be identified by matching line patterns on the skin as a characteristic of the tiger using the template matching method, namely comparing the similarities between the lines pattern in the reference image with the main image. However, the presence of plant leaves and shrubs with various shapes could disguise tiger skin line patterns so that it could affect the accuracy of identification results. In this paper, we conducted a comparative study to identify tigers based on edge lines which were then processed using three edge detection method namely Canny, Laplacian and Sobel. The results of each operator were further processed using template matching algorithm to get the accuracy of object identification (tiger).

Dr. Sanjay Shukla

INDIA

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Anatomy

Tomar, M. P. S., Taluja, J. S., Vaish, R., Shahi, A., Shrivastav, A. B., and Sumbria, D. (2019). Gross anatomy of femur in Royal Bengal Tiger (Panthera tigris). Indian Journal of Veterinary Anatomy, 31(1), 75-76. *http://epubs.icar.org.in/.../36903*.

ABSTRACT

The present study was carried out on the femur of five adult tiger skeletons. In tiger, the femur was the longest bone of the appendicular skeleton. It presented a shaft and two extremities. Trochanter major was slightly higher in position than the head. Trochanteric crest was terminated in to a tubercle just below the trochanteric fossa and did not meet the trochanter minor. Larger distal extremity was consisted of trochlea and condyles. The intercondyloid fossa was wide, rough and quadrangular in shape. During morphometry, a nonsignificant difference was noticed in the bone of two hind limbs which may be of biomechanical importance.

Behavior

Tyagi, A., Kumar, V., Kittur, S., Reddy, M., Naidenko, S., Ganswindt, A., and Umapathy, G. (2019). Physiological stress responses of tigers due to anthropogenic disturbance especially tourism in two central Indian tiger reserves. Conservation Physiology, 7(1), coz045. *https://doi.org/10.1093/conphys/coz045*.

ABSTRACT

Tigers continue to face unprecedented threats to their existence due to poaching, habitat loss, habitat fragmentation and anthropogenic disturbances. The present study examines the physiological stress response of tigers due to anthropogenic activities including wildlife tourism in Bandhavgarh Tiger Reserve and Kanha Tiger Reserve using faecal glucocorticoid metabolite (fGCM) measurement. We collected a total of 341 faecal samples from both reserves during tourism and nontourism periods. Data on various anthropogenic disturbances including tourism activities like number of vehicles and visitors were also collected. We ascertained the species identity and sex of all the samples collected using genetic markers. fGCMs were extracted using a previously reported procedure, and fGCM concentrations were subsequently determined using an established enzyme immunoassay. There was no significant difference

in overall mean fGCM concentrations between the two tiger reserves, but within each reserve, concentrations were significantly higher in tigers during the tourism period as compared to the non-tourism period. We also found that the number of tourist vehicles and disturbance level significantly correlated with fGCM concentrations. This study further supports the assumption that unbridled tourism associated with high anthropogenic disturbance can be related to perceived stress and consequently may have an impact on the reproductive fitness of tigers and long-term survival of isolated populations.

Ecology

Bisht, S, Banerjee, S, Qureshi, Q, Jhala, Y. (2019). Demography of a high-density tiger population and its implications for tiger recovery. J Appl Ecol, 56: 1725–1740. *https://doi.org/10.1111/1365-2664.13410*.

ABSTRACT

Prioritizing conservation of source populations within landscapes is proposed as a strategy for recovering tigers globally. We studied population dynamics of tigers in Corbett National Park (CNP) in Indian Terai, which harbours the largest and highest density tiger population in any protected area of the world. Through population viability models, we demonstrate the importance of CNP in tiger recovery within western Terai. We camera trapped 521 km^2 of CNP using open population capture–mark–recapture framework between 2010 and 2015 to estimate annual abundance, spatially explicit density, survival, recruitment, temporary movements, sex ratio and proportion of females breeding. We model metapopulation persistence with and without Corbett as a source within western Terai landscape at different levels of poaching and habitat connectivity. In 6 years, we recorded 6,202 photo-captures of 307 individual tigers. Annual tiger abundance and density were stable at 120 (SE 19) and 14 (SE 3) per 100 km^2 respectively. Detection probability of tigers was 0.18 (SE 0.03) and detection-corrected male:female sex ratio was female biased (0.80 SE 0.13). Apparent annual survival probability was 0.79 (SE 0.05) for females and 0.60 (SE 0.04) for males. Survival of tigers in CNP (0.68 SE 0.12) was lower than that reported for other populations. CNP tigers showed high reproduction with 54.8 (SE 5.1)% females breeding and with addition of 35 (SE 8)% as new recruits to the population each year. Small tiger populations in western Terai with moderate poaching could only persist through dispersal from CNP. Synthesis and applications. Corbett tiger population was characterized by a stable high density, high reproductive rate and low survival, resulting in high turnover rates (32%–48%) between successive years. Such source populations could sustain low-level poaching and with habitat connectivity, recover tiger populations across the landscape. This study establishes potential thresholds that can likely be achieved by tiger populations under optimal natural conditions and highlights the importance of prioritizing conservation of source populations within tiger landscapes. This information can be used to plan and implement realistic tiger recovery programmes globally.

Bisht, S. (2019). Population Dynamics and Resource Selection by Tigers in Corbett Tiger Reserve. (Doctoral Dissertation). Saurashtra University, Department of Wildlife Science.

SUMMARY

Large carnivores are on the brink of extinction across most of their range and this is especially true for tigers, that are symbolic of the wilderness of the Asian forests. India is the stronghold for tigers in the world but their distribution is restricted to patches in a landscape. Largest tiger populations, not only in India but also in the world, are found in the Western Ghats (Karanth et al 2006), in the mangroves of the Sunderban (Roy et al. 2015) and in the western Terai landscape of Corbett (Bisht et al 2019). Among these the densest population of tigers is found in Corbett, but information on vital rates such as survival, recruitment, reproductive potential, along with space use and food habits of tigers from such a system are not known. The overarching goal of my study was to use camera trap based capture mark recapture (CMR) technique to understand the population dynamics and space use by tigers in this high density tiger population. For this I camera trapped 521 km^2 of Corbett National Park (CNP) under open population capture–mark–recapture framework between 2010 and 2015 to estimate annual abundance, spatially explicit density, survival, recruitment, temporary movements, sex ratio and proportion of females breeding. In 6 years, we recorded 6,202 photo-captures of 307 individual tigers. Annual tiger abundance and density were stable at 120 (SE 19) and 14 (SE 3) per 100 km^2 respectively. Detection probability of tigers was 0.18 (SE 0.03) and detection corrected male:female sex ratio was female biased (0.80 SE 0.13). Apparent annual survival probability was 0.79 (SE 0.05) for females and 0.60 (SE 0.04) for males. Survival of tigers in CNP (0.68 SE 0.12) was lower than that reported for other populations. CNP tigers showed high reproduction with 54.8 v (SE 5.1) % females breeding and with addition of 35 (SE 8) % as new recruits to the population each year. Like the current study, monitoring programs are dependent on a robust sampling method since inferences on population growth or decline are very important for management of a protected area and are sensitive to the assumptions of the sampling method. As part of the current study we tested the effect of sampling days on the estimates of abundance in a closed CMR study. We camera trapped an area of 100 km^2 for one year continuously and obtained 1940 photographs of 26 tigers in 18,475 trap-days. We estimated abundances for increasing sampling windows (15-90 days) by iterating closed CMR analysis from 50 random start occasions for each window. Tiger abundance increased asymptotically from 15 to 22 and precision increased from 22 to 7 % CV with increasing sampling window. The increase was drastic between 15-45 days (15% per day) compared to 45-90 days (4% per day). We used open Robust Design models (Pradel and Pollock) on primary periods of 24 days, along increasing interval between two sampling periods

(0-90 days) to examine how enlarging the sampling window influences detection probability and demographic parameter estimates. Small sampling windows (<30days) positively biased detection probability as individual heterogeneity in capture rates could not be accounted for; yielding negatively biased estimates of abundance (-27% bias). Recruitment rate (new adults at time t per adult at t-1) and apparent mortality (1-S) increased with sampling window; indicating that population change (additions + deletions) increased from 2% (48 days) to 18% (120 days). Although temporary emigration rate was constant across sampling windows (~11% between 48-120 days), temporary immigration rate increased abruptly from 18% (48-60 days) to 86% (60-120 days); vi indicating that violation of geographic closure cannot be completely avoided and can bias the abundance estimate if the sampling extends beyond 60 days. We suggest using the sampling window suggested here to optimize the trade-off between unbiased detection probability estimation (>25 days) and tolerable levels of individual turnovers (5% in < 60 days). Most of our knowledge on space use and food habits of tigers in India comes from the tropical deciduous forests of western ghats and central India. We looked at space use and food habits of tigers in Corbett, which has high competition for space, high turnover and also high reproductive potential. Cervids accounted for 90% of the tigers diet and Chital (Axis axis) was the preferred prey. We used camera trapped based minimum home range estimates for resident male and female home ranges, shifts, expansions/contraction and overlaps. Home range of males (n=15) 16.4 + 1.6 km^2 was 5 times more than the home range of females (n=14, 3.9 + 0.8 km^2). None of the resident females showed shifts in its home range area while 4 of the males, 2 of them sub adults, showed shifts and home range expansion between 2010 and 2015. We found relatively high overlap between females (16%) than reported by other studies and males had an average overlap of 34%. Smaller annual minimum homerange usage areas of the breeders/residents and high female home range overlap than those reported for tigers (see Sunquist 1981, Simchareon et al. 2014 and Chundawat et al. 2016) suggests adjustment in space in response to high competition in CNP.

Mallick, J. K. (2019). Panthera tigris: Range and population collapse in Northern West Bengal, India. Biodiversity International Journal, 3(3), 110-119.

ABSTRACT

During the last two centuries, tiger population has been extirpated from about 1,000km^2 of its historic range in Northern West Bengal and dwindled at an alarming rate in their last refuse, i.e. the protected areas, spread over >1,000km^2, due to increasing anthropogenic pressures and other reasons. Intra-state and inter-state migration of the tigers, usually on a seasonal basis, is also reported from these protected areas, leading to very much lower population than in ecologically comparable sites in India.

Navaneethan, B., Sankar, K., Manjrekar, M.P., and Qureshi, Q. (2019). Food habits of tiger (Panthera tigris tigris) as shown by scat analysis in Bandhavgarh Tiger Reserve, Central India. 8(2), 224-227.

ABSTRACT

Tiger (Panthera tigris) is a large terrestrial carnivore found in diverse habitat types showing remarkable toler-ance to variation in altitude, temperature and rainfall (Schaller, 1967; Sanquist et al., 1999). Being an um-brella species, its effective conservation enhances sur-vival prospects for other forms of biodiversity (Karanth, 2003). In carnivores, the life history strategies largely depend on several factors like food, spacing pattern, habitat selection, distribution and movement pattern (Bekoff et al., 1984; Sunquist and Sunquist, 1989) and among them, food is a vital resource for carnivores (Jedrezejewski et al., 1989). Carnivores, especially ti-gers are morphologically specialized to kill large bodied prey species (Schaller, 1967). Especially tigers prey upon large to medium bodied ungulates in all the eco-systems in which they occur (Seidensticker, 1997; Karanth, 2003). They can potentially hunt prey varying from small mammals to the largest of the bovids (Biswas and Sankar, 2002). Although tigers do kill smaller prey, ranging from peafowl to prawns, they can-not survive and reproduce if a habitat does not support adequate densities of ungulates (Sunquist and Sunquist, 1989). Food habits are of basic importance when trying to understand the ecology and natural history of carni-vores (Miquelle et al., 1996). Studies on tiger prey se-lection have been scarce in tropical forests (Schaller, 1967; Griffiths, 1975; Johnsingh, 1983; Rabinowitz and Nottingham, 1986; Emmons, 1987; Rabinowitz 1989, Biswas and Sankar 2002; Ramesh et al., 2009; Majumder et al., 2012).

Rekha, W. (2019). Conserving Tigers Beyond Protected Area Boundaries: The Spatial Ecology of Tigers and Their Prey In Farmlands In North India (Doctoral dissertation), Colorado State University, Fort Collins, Colorado.

ABSTRACT

The study conducted in the Central Terai Landscape (CTL) in India focused on understanding the dynamics of large carnivores, specifically tigers, and their interactions within human-modified landscapes. The research aimed to bridge the gap in knowledge regarding the ecology of these species outside protected areas. The researcher investigated tiger spatial ecology and that of their herbivorous prey, along with human-carnivore interactions within an agricultural corridor between two protected areas. Through surveys using various methods across different seasons, they discovered that tigers extensively used the matrix area beyond protected boundaries, primarily during winter when cover and resources were abundant. This

suggested the importance of these areas for tigers, not just as dispersal routes but also as crucial habitats for breeding and prey resources.

Additionally, the study examined the space use patterns of herbivorous species like hog deer, wild boar, and nilgai within farmlands. These species demonstrated consistent use of agricultural areas resembling their natural habitats, unlike some other species associated with forests or tall grasslands, which were scarcely found in farmlands. Interestingly, the perception of species distribution by local farmers often differed from the actual distribution observed in the study.

Furthermore, the research introduced an analytical framework to model species' spatial distribution and their interactions with humans, specifically focusing on conflicts with wild boar. This model highlighted that farmers tended to report conflicts with wild boar even in places where the species wasn't present, indicating a high false-positive reporting rate.

Overall, the findings emphasized the significance of incorporating human-modified landscapes into conservation strategies, suggesting the need for extending conservation efforts beyond protected areas. Understanding these complex interactions between wildlife and humans becomes pivotal for effective conservation practices, especially as human populations continue to encroach upon wildlife habitats.

Kumar, U. (2019). Tiger and Leopard Population Ecology and Resource Partitioning of Sympatric Carnivores in Kanha Tiger Reserve, M.P. (Unpublished doctoral dissertation). Saurashtra University, Department of Wildlife Science. Retrieved from *http://hdl.handle.net/10603/345346*

SUMMARY

Large investment in the form of protected areas, human resettlement, law enforcement-patrols and habitat management are made to conserve tigers and reap their benevolent umbrella role to secure India's biodiversity. Tigers and leopards share their entire range except in mangrove forest of Sundarbans in India. Their populations are under severe threat across the entire range, primarily because of poaching and habitat fragmentation. Both carnivores shape the ecosystem function by virtue of their top position in the food chain.In spite of their ecological importance, there are limited studies on their longterm population ecology and co-existence. To best plan conservation strategies at the landscape level, it is crucial to understand the population dynamics of tiger and leopard. Hence, I attempted to study (i) the trend of tiger and leopard population (ii) demography of tigers and leopards and mechanism of their coexistence.2. My study area was Kanha tiger reserve (area 2074 km^2), a major stronghold for both species in central Indian landscape. The tiger reserve has two management units core zone (917 km^2) devoid of human settlements and a multiple use buffer zone (1165 km^2) comprised by revenue and protected forests and agriculture fields. The core zone, which is also called as Kanha National Park, is part of two river catchments Banjar and Halon. Camera trap based mark-recapture framework were used to estimate population dynamics (densities, population trend survival and recruitment) of tigers and leopards. Camera traps were placed in the dirt road, animal trails and riverbeds to maximize the capture of tiger and leopards. Initial two years (2011-2012) the sampling area were small as 280 km^2 in Banjar catchment and 180 km^2 in Halon catchment (with one camera station in 4-5 km^2) but later from 2013 to 2017 with extra resources I was able to sample entire core zone (917 km^2) with high camera trap densities (with one camera station in 1-2 km^2). 3. Population trends of the threatened species are required for evaluating the success of management actions and prioritizing conservation investments. Densities of tigers and leopards, their sex ratios and population trend over six years were estimated through multisession maximum likelihood based spatially explicit capture recapture models (secr). SECR has two basic parameters i) g0 the detection at activity centre and ii) σ the spatial scale of detection e.g. movement parameter. I accounted for major potential sources of variability in the data by modelling g0 and σ as a function of gender and sampling year (as density was likely to change between years and potentially alter σ). Tiger density of Kanha PA (at 100 km-2) ranged from 4.82 ± 0.33 to 5.21 ± 0.55 and the leopard densities (at 100 km-2) varied between 6.63 ± 0.71 to 8.64 ± 0.75. Overall sex ratio in Kanha National Park (M:F) was biased towards females for both tigers (0.66 ± 0.03) and leopards (0.50 ± 0.02). The density for both tigers and leopards in Banjar catchment showed growth with a λ = 1.10 (CI95% 1.02-1.18) for tigers and λ = 1.15, (CI95% 1.05-1.27) for leopards. While for the Halon catchment tiger and leopard density remained stable at λ = 0.98 (CI95% 0.86-1.14) and λ = 1.09 (CI95% 0.98-1.22). Tiger and leopard densities were stable at the PA scale but I found at the local scale Banjar catchment that had had higher prey density and high conservation investments, recorded significant growth for both carnivores. While Halon catchment that had low prey and lower investments, tiger and leopard populations were stable. 4. Key vital rates such as reproductive parameters and survival rates are important to device recovery strategies for endangered carnivores. I estimated vital parameters of tiger demography through robust design based classical open population models in which population was open to demographic process (recruitment, deaths, immigration and emigration) during the period of 7 years (2011-2017) from 147 adult tigers (>1 year) and by collating information on survival and reproductive parameters by regular monitoring of 127 known tigers from all age groups. I estimated mean litter size (n=31) to be 3.24 (± 0.63), inter birth interval (n=29) to be 22 ± 2.7 months, age of first reproduction (n=11) to be 3.30 ± 0.13 years. Age specific survival estimateswas the lowest for cubs (0.59 ±0.06), and highest for adult stage (3-10 years) e.g. for males (0.87 range 0.69 -0.95) and females (0.92 range 0.80-0.97). Female showed higher survival throughout their adult stages. Male tigers exhibited a typical Type II survivorship curve while survivorship of tigresses was a curve between Type I & II. The apparent survival from robust design camera

trap based open population model was also female-biased (0.84 ±0.03) compared to male (0.78 ± 0.05). Since I had estimates of actual adult gender specific survival from the same population contemporaneously from known fate models along with apparent survival obtained by camera trap based robust design, I could estimate emigration (dispersal) for each gender in adult tigers.I estimated that about 9% of males and 8% of females annually dispersed outside to the study area and repopulate the nearby tiger landscape. Results of this study concede the importance of wildlife corridors between protected areas for long-term survival. Kanha is the largest source population in central India and well connected to the Pench, Achannakmar, Navegaon Nagzira tiger reserves.5. Leopard is one of the most widespread carnivores but information on population dynamics such as survival and reproductive parameters are remarkable scares. Demographic parameters for leopards through camera trap based studies was challenging since they have low detection rate in camera traps resulting zero inflated capture-recaptures, especially in the areas where they share their resources to congeneric large carnivores. The density and other population parameters estimate based on low detection rate are imprecise and of limited value. By experience gained in initial three years, I increased camera densities to better optimize for leopard detections. The classical open population Non-spatial models are sensitive to zero-inflated capture-recaptures resulting parameters un-identifiability and imprecise estimates. Non-spatial models cannot differentiate between mortality and emigration, but the Bayesian spatial open population models allow to model the movement and separate emigration from mortality, they provide more realistic estimates of demographic parameters with fewer restrictive assumptions. In this study, I used Bayesian open population spatial capture recapture models to estimate demographic parameters such as sex specific survival, recruitment and population growth rate for the leopard. Contrary to expectation, the survival estimates were low for females (0.69 range 0.61 – 0.75) compared to males (0.83 range 0.76 – 0.91) in leopards. The sex ratio was overall female biased throughout the sampling years. Average recruitment rate in the population was high for female (0.29 range 0.22 – 0.35) and low for male (0.07 range 0.04– 0.10); this likely suggests a scenario where low survival but higher proportion in the population and high recruitment is possible when sex ratio at birth is skewed towards females. The high mortality of female was compensated by higher recruitment rate to give female-biased sex ratios. This could be likely a function of high tiger density in the PA, and female leopards are more vulnerable to intraspecific predation by tiger due to their small size, small home range and higher spatial philopatry. 6. Sympatric species of similar guilds can potentially compete for resources such as food and space. Tigers co-occur with the leopards in their entire range except in mangrove forest of Sundarbans in India. Both top predators have similar diets. Tiger and leopard co-exist together by resource partitioning on the scale of space, time and diet. In this study, I investigated the mechanism of co-existence of both predators. For spatial partitioning spatial densities were estimated through secr model for of both the species. To understand how leopard population responds to tiger densities and growth at the scale home range size of breeding tigress (10 km^2), growth rate were estimated

for both the carnivores by regressing ln(density) against year. Contour plots for leopard growth rates against tiger density and against tiger growth rates were drawn in NCSS to evaluate the demographic response of leopards to tiger demography. I found that at tiger home range scale (10 km^2 grids), leopards achieved high density in areas with medium or declining tiger density. Leopard populations showed growth in areas with low to medium-stable tiger density or declining tiger density. I also evaluated the response of predator densities with increasing distance from PA boundary. Tiger densities steeply declined with the increasing distance from protected area, leopards, known to be better adapted to survive near humans use buffer zone without exhibiting multi-modal density declines as seen in tigers. 7. To assess the temporal activity pattern of tiger and leopards in Kanha tiger reserve, I used time of photo-capture obtained from the camera trap pictures. I found tigers and leopards were primarily nocturnal with high overlap in activity (86% range 83 -89). I collected scats of both the predator to assess the diet and I found high overlap in diet composition. The mechanism of diet overlap and coexistence is related to high and diverse prey availability in Kanha tiger reserve, which is likely to be associated with habitat heterogeneity. The heterogeneous habitat with ample prey facilitates coexistence between these two carnivores8. This was the first study which used both camera trap based mark-recapture and continuous monitoring known fate information to estimate reproductive parameters along with age specific survival and dispersal probability of tigers. First study on leopards for estimating sex-specific actual survival and recruitment rate using novel non-invasive open population spatial capture recapture models. Such information is crucial to develop conservation strategies for these threatened carnivores.

Upadhyay, H.S., Behera, S., Dutta, S.K., Sahu, H.K., and Sethy, J. 2019. A viable tiger population in Similipal Tiger Reserve, India? Calculating if the ungulate prey base is limiting. Wildlife Biology, 2019(1), pp.1-7.

ABSTRACT

Low ungulate density can be a factor in limiting tiger populations, so to better manage tiger reserves one must be able assess if this is the case or if other factors might be more important. Here, we quantify ungulate density in a tiger reserve in India, compare it to other reserves, and estimate the tiger carrying capacity in order to assess this reserve can support a viable tiger population. Specifically, we studied the Similipal Tiger Reserve (STR), Odisha, India, from 2011 to 2014. The line transect method was used to estimate population density of available major ungulate prey species, i.e. sambar Rusa unicolor, wild pig Sus scrofa, barking deer Muntiacus muntjac, chital Axis axis and mouse deer Moschiola indica. A remarkable increase in ungulate prey density was noted in the intensive study area over the study period from 4.3 animals per km2 in the pre-monsoon season of 2011 to 28.9 animals per km2 in the post-monsoon season of 2014. This estimated ungulate density is very low compared to other tiger reserves of India.

Density figures of ungulates when multiplied with the average weight of the respective species gave a biomass density of 1599.4 kg km-2. This data was then used in two published empirical models to obtain estimates of tiger carrying capacity in STR. We used two empirical models from the published literature and concluded that the tiger carrying capacity of Similipal Tiger Reserve ranges between 1.3 and 3.8 tigers per 100 km^2, much lower than our current estimates of tiger density. This suggests that the tiger population is below carrying capacity or that the estimated tiger population in critical tiger habitat falls below the threshold number. We suggest that the creation of large meadows for herbivores and the establishment of suitable fenced areas to augment breeding of the prey species chital and sambar are necessary to support a viable tiger population in the Similipal Tiger Reserve.

History

Rajarshi, M. (2019). To Hunt or Not to Hunt: Tiger Hunting, Conservation and Collaboration in Colonial India. International Journal for History, Culture and Modernity, 7, 815-837.

ABSTRACT

As the Edwardian era came to an end in Britain and its Empire began to decline, the glorious days of tiger hunting in India were being measured against a genuine fear of the total extinction of tigers. This article maps the precarious position of Indian tigers in the hands of hunters against the rising concern over preservation of the species in the first half of the twentieth century. Ranging from the bureaucratic to the overtly sentimental and personal, these attitudes, taken together, reveal a pre-'Project Tiger' conservation milieu in colonial India. They help us to judge the cultural status and symbol of the Bengal tiger before it became an iconic species for wildlife conservation in postcolonial India. The various debates and representations of tigers in hunting memoirs often throw light on intricate socio-cultural problems threatening the survival of the cat. In fact, the debates, as much as they spread awareness, ended up strengthening the bureaucratic and sometimes political hold over Indian forests. The article further tracks imperial discourse on the systematization of tiger hunts, which was effectively linked with the preservation of tigers and collaboration with Indians. During the twilight of the British Empire, tiger hunt and tiger conservation would emerge as sites for possible collaboration between Indians and their rulers. As recent efforts at international collaboration to protect tigers have shown, the tiger retains enough sentimental value to secure bureaucratic and political ties between nations.

HUMAN WILDLIFE INTERACTION AND CONFLICT MITIGATION

Lele, Y., and Sharma, J. V. (2019). Carbon finance: Solution for mitigating human-wildlife conflict in and around critical tiger habitats of India (TERI Policy Brief). New Delhi: The Energy and Resources Institute.

SUMMARY

The report discusses the potential of generating carbon finance through the Climate, Community and Biodiversity Standards (CCBS) approach to mitigate human-wildlife conflict and conserve biodiversity in critical tiger habitats in India. It emphasizes the need for a carbon neutrality policy in India to ensure financial benefits for local communities involved in conservation efforts. The report suggests the establishment of an institutional framework, including Ecodevelopment Committees (EDCs) and a management committee, to manage carbon finance projects and ensure direct benefits to communities. The finance generated through the carbon finance project would be transferred to the respective EDCs for community development and biodiversity conservation activities. The report highlights the importance of integrating ecosystem services in India's climate neutrality policy and the potential contribution of carbon finance projects towards climate change mitigation and restoration of degraded land.

Packer, C., Shivakumar, S., Athreya, V., et al. (2019). Species-specific spatiotemporal patterns of leopard, lion, and tiger attacks on humans. Journal of Applied Ecology, 56, 585–593. *https://doi.org/10.1111/1365-2664.13311*.

ABSTRACT

Large carnivores of the genus Panthera can pose serious threats to public safety. Although the annual number of attacks on humans is rare compared to livestock depredation, such incidents undermine popular support for wildlife conservation and require immediate responses to protect human life.

2. We used a space–time scan method to perform a novel spatiotemporal analysis of 908 attacks on humans by lions, leopards, and tigers to estimate the risks of further attacks in the same locales.

3. We found that a substantial proportion of attacks were clustered in time and space, but the dimension of these outbreaks varied between species. Lion outbreaks included more human

fatalities, persisted for longer periods of time, and extended over larger areas than tiger or leopard outbreaks.

4. Synthesis and applications. Our analysis reveals the typical spatiotemporal patterns of past lion, leopard, and tiger attacks on humans. In future, this technique could be used by relevant agencies to warn local people of risks from further attacks within a certain time and distance following an initial incident by each species. Furthermore, the approach can help identify areas requiring management interventions to address such threats.

Ramesh, T., Kalle, R., Sankar, K., Qureshi, Q., Giordano, A.J., and Downs, C.T. 2019. To resettle or not?: socioeconomic characteristics, livelihoods, and perceptions toward resolving human-tiger conflict in the Nilgiri Biosphere Reserve, India. Land Use Policy, 83, pp.32-46.

ABSTRACT

As pressure from a growing human population increases around the world, greater levels of conflict between people and wildlife over shrinking available land may be inevitable. The conversion of Mudumalai Wildlife Sanctuary to Mudumalai Tiger Reserve (MTR) in India is a conservation initiative under "Project Tiger" scheme to facilitate greater habitat connectivity across the Nilgiri Biosphere Reserve. We interviewed local people in the MTR landscape to determine their interest and attitude towards resettlement and tigerconservation following MTR's new status designation. We found that non-tribal Mountain Chetties generally had negative attitude towards tiger conservation, Kurumbas were positive toward the idea, and Kattunaickers, and Irula people and other minor ethnic groups were found neutral. We found that literate respondents were less likely to collect firewood and more likely to exhibit positive attitude towards tiger conservation and the establishment of MTR. Households with higher milk production, and people with generally negative attitude towards wildlife conservation, were against the declaration of MTR. People employed in private sectors and those having negative perception towards wildlife conservation were more likely to show negative attitude towards declaration of MTR. Locals desiring resettlement post MTR declaration were literate, and interested in availing better livelihood resources. However, they usually suffered relatively high livestock loss to large carnivores, and high crop damage caused by elephant (Elephas maximus). Most respondents (74.3%) were interested in resettlement provided that basic amenities were available to them. We recommend that conservation authorities facilitate "choice-based resettlement" options, which account for local people's consent before making decisions on "resettlement". This approach will avoid possible conflicts between forest managers and local people.

CONSERVATION, MANAGEMENT AND POLICY RECOMMENDATION

Gopalaswamy, A. M., Karanth, K. U., Delampady, M., and Stenseth, N. C. (2019). How sampling-based overdispersion reveals India's tiger monitoring orthodoxy. Conservation Science and Practice, 1, e128. *https://doi.org/10.1111/csp2.128*

ABSTRACT

Agencies responsible for recovering populations of iconic mammals may exaggerate population trends without adequate scientific evidence. Recently, such populations were termed as "political populations" in the conservation literature. We surmise such cases are manifested when agencies are pressured to estimate population parameters at large spatial scales for elusive species. For example, India's tiger conservation agencies depend on an extrapolation method using indexcalibration models for estimating population size. A recent study demonstrated mathematically the unreliability of this approach in practical situations. However, it continues to be applied by official agencies in Asia and promoted further by global organizations working on tiger conservation. In this article, we aim to: (a) discuss the ecological oddities in the results of India's national tiger surveys, (b) contrast these survey approaches to known statistical approaches for large scale wildlife abundance estimation, (c) demystify the mathematics underlying the problems with the survey methodology, and (d) substantiate these arguments with results from India's national tiger survey of 2014. Our analyses show that the predictions of tiger abundance reported by the 2014 survey, and consequently on tiger population trends, are misleading because of the presence of high sampling-based overdispersion and parameter covariance due to unexplained heterogeneity in detection probabilities. We plead for designing monitoring programs to answer clearly defined scientific or management questions rather than attempt to meet extraneous social or funding related expectations.

Kumar, U., Awasthi, N., Qureshi, Q., et al. (2019). Do conservation strategies that increase tiger populations have consequences for other wild carnivores like leopards? Scientific Reports, 9, 14673. *https://doi.org/10.1038/s41598-019-51213-w*

ABSTRACT

Most large carnivore populations are declining across their global range except in some well managed protected areas (PA's). Investments for conserving charismatic apex carnivores are often justified due to their umbrella effect on biodiversity. We evaluate population trends of two large sympatric carnivores, the tiger and leopard through spatially-explicit-capture-recapture models from camera trap data in Kanha PA, India, from 2011 to 2016. Our results show that the overall density (100 km−2) of tigers ranged between 4.82 ± 0.33 to 5.21 ± 0.55SE and of leopards between 6.63 ± 0.71 to 8.64 ± 0.75SE, with no detectable trends at the PA scale. When evaluated at the catchment scale, Banjar catchment that had higher prey density and higher conservation investments, recorded significant growth of both carnivores. While Halon catchment, that had lower prey and conservation investments, populations of both carnivores remained stable. Sex ratio of both carnivores was female biased. As is typical with large carnivores, movement parameter sigma (an index for range size), was larger for males than for females. However, sigma was surprisingly similar for the same genders in both carnivores. At home-range scale, leopards achieved high densities and positive growth rates in areas that had low, medium or declining tiger density. Our results suggest that umbrella-species conservation value of tigers is likely to be compromised at very high densities and therefore should not be artificially inflated through targeted management.

Margulies, J. D. (2019). Making the 'man-eater': Tiger conservation as necropolitics. Political Geography, 69, 150-161. *https://doi.org/10.1016/j.polgeo.2018.12.011*

ABSTRACT

In this article I analyze the practice and politics of classifying a tiger as a 'man-eater' in South India to explore what doing so reveals more broadly about the relations between animal life and the kinds of human life marked as expendable by the state. I draw on Achille Mbembe's theory of necropolitics in order to analyze how the Indian State attempts to manage human-wildlife relations in a contested plantation landscape of high priority for wildlife conservation. While there is a large literature theorizing wildlife and biodiversity conservation as the practice of biopolitics, I argue conservation, as both a typology of space and set of ideologically malleable practices, remains under-theorized as a form of necropolitics, the politics mediating death. I examine how the Indian State goes about reclassifying tigers from a strictly protected endangered species to killable—the process of making the 'man-eater'—in relation to how the

state both values and devalues human and non-human life as a process rooted in colonial histories of accumulation by dispossession. This article responds to calls across political ecology and political geography to better theorize the role of non-human animals as essential subjects of inquiry in political contestations. It does so through exploring the spatial contours of deadly encounter between plantation workers and tigers in the plantation-conservation necropolis.

Mukul, S. A., Alamgir, M., Sohel, M. S. I., Pert, P. L., Herbohn, J., Turton, S. M., Khan, M. S. I., Munim, S. A., Reza, A. H. M. A., and Laurance, W. F. (2019). Combined effects of climate change and sea-level rise project dramatic habitat loss of the globally endangered Bengal tiger in the Bangladesh Sundarbans. Science of The Total Environment, 663, 830-840. *https://doi.org/10.1016/j.scitotenv.2019.01.383*.

ABSTRACT

The Sundarbans, in southern coastal Bangladesh, is the world's largest surviving mangrove habitat and the last stronghold of tiger adapted to living in a mangrove ecosystem. Using MaxEnt (maximum entropy modeling), current distribution data, land-use/land cover and bioclimatic variables, we modeled the likely future distribution of the globally endangered Bengal tiger (Panthera tigris tigris) in the Bangladesh Sundarbans. We used two climatic scenarios (i.e., RCP6.0 and RCP8.5) developed by the Intergovernmental Panel on Climate Change (IPCC) to provide projections of suitable habitats of Bengal tigers in 2050 and 2070. We also combined projected sea-level rise for the area in our models of future species distributions. Our results suggest that there will be a dramatic decline in suitable Bengal tiger habitats in the Bangladesh Sundarbans. Other than various aspects of local climate, sea-level rise is projected to have a substantial negative impact on Bengal tiger habitats in this low-lying area. Our model predicts that due to the combined effect of climate change and sea-level rise, there will be no suitable Bengal tiger habitat remaining in the Sundarbans by 2070. Enhancing terrestrial protected area coverage, regular monitoring, law enforcement, awareness-building among local residents among the key strategies needed to ensure long-term survival and conservation of the Bengal tiger in the Bangladesh Sundarbans.

Neelakanthan, A. (2019). Moving people for Tigers: Resettlement, Food Security and Landscape-Level Conservation in Central India (PhD Thesis), University of Columbia, United States.

ABSTRACT

This dissertation explores the impact of resettlement on both communities and conservation in India's Kanha National Park. It investigates food security, landscape connectivity for wildlife, and human-wildlife conflict. Findings show that resettled households have similar food access as non-resettled neighbors, with increased off-farm incomes improving food access for all. Financial stability plays a crucial role, overshadowing social and natural capitals. Resettled households aren't moving disproportionately into wildlife corridors but are relocating near high conflict zones. Stable incomes can reduce forest use and conflict. Contrary to assumptions, resettled communities aren't heavily reliant on natural resources but integrate into urban economies. The study suggests that boosting off-farm salaried incomes can enhance food security and aid conservation efforts. This research offers insights applicable to other protected areas in India, given the standardized resettlement policies across diverse landscapes.

Qureshi, Q., Gopal, R., and Jhala, Y. (2019). Twisted tale of the tiger: the case of inappropriate data and deficient science. PeerJ, 7, e7482. *https://doi.org/10.7717/peerj.7482*.

ABSTRACT

Publications in peer-reviewed journals are often looked upon as tenets on which future scientific thought is built. Published information is not always flawless and errors in published research should be expediently reported, preferably by a peer-review process. We review a recent publication by Gopalaswamy et al. (10.1111/2041-210X.12351) that challenges the use of “double sampling" in largescale animal surveys. Double sampling is often resorted to as an established economical and practical approach for large-scale surveys since it calibrates abundance indices against absolute abundance, thereby potentially addressing the statistical shortfalls of indices. Empirical data used by Gopalaswamy et al. (10.1111/2041-210X.12351) to test their theoretical model, relate to tiger sign and tiger abundance referred to as an Index-Calibration experiment (IC-Karanth). These data on tiger abundance and signs should be paired in time and space to qualify as a calibration experiment for double sampling, but original data of IC-Karanth show lags of (up to) several years. Further, data points used in the paper do not match the original sources. We show that by use of inappropriate and incorrect data collected through a faulty experimental design, poor parameterization of their theoretical model, and selectively picked estimates from literature on detection probability, the inferences of this paper are highly questionable. We highlight how the results of Gopalaswamy et al. were further distorted in popular media. If left unaddressed, the paper of Gopalaswamy et al. could

have serious implications on statistical design of large-scale animal surveys by propagating unreliable inferences.

Vaidyanathan, G. 2019. India's tigers seem to be a massive success story - many scientists aren't sure. Nature, 574 (7780), 612-616.

ABSTRACT

A tiger and her cubs leave India's Bandhavgarh National Park in search of prey, which is scarce inside the reserve. India is trying to save its tiger population, but researchers question the country's long-term plans to protect this endangered species. The bureaucracy is difficult even for Wildlife Institute of India (WII) scientists, making it challenging to obtain permits. Releasing raw data and model information to ecologists for independent analysis could help resolve disagreements, but concerns about poaching and the tiger's status as a symbol of national pride hinder this process. The tourism industry around tiger safaris and luxury resorts may contribute to saving the tiger from extinction. The latest census suggests that tiger numbers have increased since 2014.

Dhritiman Mukherjee

GENETICS AND FORENSICS

Forensics

Sharma, C. P., Sharma, S., Sharma, V., and Singh, R. (2019). Rapid and non-destructive identification of claws using ATR-FTIR spectroscopy-A novel approach in wildlife forensics. Science and justice: journal of the Forensic Science Society, 59(6), 622–629. *https://doi.org/10.1016/j.scijus.2019.08.002*.

ABSTRACT

Differentiation and identification of Royal Bengal Tiger (Panthera tigris tigris) and Indian Leopard (Panthera pardus fusca) claws is a challenging task in wildlife forensics, due to similarity in their morphology, anatomy and chemical compositions as both the species are closely related to each other genetically. ATR-FTIR spectroscopy, which offers a non-destructive and safe alternative technique to other conventional methods, has been employed in the present work to differentiate claws of Royal Bengal Tiger and Indian Leopard. An attempt has been made to differentiate 31 reference claw samples from 16 different Royal Bengal Tigers, 15 different Indian Leopards, and 10 fake claws using ATR-FTIR spectroscopy supplemented with PCA, PLS-DA, and LDA. PCA could not distinguish the samples of two closely related species among themselves as well as from the fake claws. On the other hand, PLS-DA and LDA models both yielded highly significant classification rate for differentiation among the samples of Royal Bengal Tiger, Indian Leopard, and their fake counterparts. Further, seven blind claw samples that were pretended to be unknown to the analyst of both the species are also examined and identified correctly to their respective groups. The R-Square value obtained for PLS-DA model to differentiate Royal Bengal Tiger, Indian Leopard, and fake claws is 0.99, which is highly significant for predictive accuracy. This study shows that ATR-FTIR spectroscopy with PLS-DA/LDA has a potential to present a rapid, non-destructive, reliable, and eco-friendly approach for the accurate identification and differentiation of Royal Bengal Tiger and Indian Leopard claws.

Sanjay Shukla

Genetics

De, R., Joshi, B. D., Shukla, M., et al. (2019). Understanding predation behavior of the tiger (Panthera tigris tigris) in Ranthambore Tiger Reserve, Rajasthan, India: Use of low-cost gel-based molecular sexing of prey hairs from scats. Conservation Genetic Resources, 11, 97–104. *https://doi.org/10.1007/s12686-017-0963-2*.

ABSTRACT

Diet reconstruction of carnivores elucidates ecology of the species and prey-predator relationship in different bioclimatic regions. Micro-histological analyses of undigested prey hairs from tiger scats have widely been used for reconstruction of predator diet. However, sex of the prey is obtained from kill data, acquiring which require extensive and intensive monitoring. The encounter rate of scats in the field is relatively higher than that of kills. Thus, we used microscopic examination of prey hairs isolated from confirmed tiger scats (n = 42) collected from Ranthambore Tiger Reserve, Rajasthan, India to identify prey species. We describe a novel method for prey sex identification from a single hair collected per tiger scat. We extracted DNA from the prey hairs and validated the absence of tiger DNA using felid specific microsatellite loci. We could amplify up to 230 bp (base pairs) nuclear and mitochondrial fragments successfully from DNA extracted from a single prey hair. We amplified a Y-linked fragment for identifying male individuals while using a mitochondrial marker as a control for PCR amplification. Sambar (Rusa unicolor) and chital (Axis axis) were the principal prey of tiger in the study area with frequencies of occurrences of 47.6 and 30.9% respectively in tiger scats. The proportions of sambar and chital males in tiger diet were 80 and 61.5% respectively. The literature indicates that cervid males are more prone to predation, possibly shaping the demography of the prey species. The results corroborated previous studies reporting male-biased predation and were consistent with the low proportion of males documented in the wild populations. This technique

can also identify the sex of young prey, which is difficult to ascertain from kills. Therefore, the described methodology holds the potential to augment information on tiger diet and underlying prey-predator dynamics to a finer resolution.

Khedkar, G., Khedkar, C., Prakash, B., Khedkar, A., Haymer, D. (2019). DNA barcode based identification of a suspected tiger skin: A case to resolve mimicry. Forensic Science International: Reports, 1, 100027. *https://doi.org/10.1016/j.fsir.2019.100027*.

ABSTRACT

An animal skin confiscated from a suspect was referred to our laboratory for DNA analysis. The investigating officer suspected that skin may have been from a tiger cub, Panthera tigris. As this tiger species is listed under the Indian wildlife protection act (1972), possession or trading of such a skin would be a serious offence. However, according to Indian law, the investigating officer has only a limited amount of time to document the species of origin of the skin, and the evidence must be presented in a way that is acceptable in a court of law. Using a DNA barcoding approach based on DNA sequences from the CO1 gene, we were able to show within the one day that the animal skin was actually the skin of a cow (Bos indicus) that had been altered to appear as a tiger skin. Although DNA barcoding is not a novel application of a method for species identification, the rapid turnaround time needed to obtain conclusive results in such cases is an important factor that brings novelty to this method in forensic investigations. Using this DNA based analysis, a case statement was prepared for the identified confiscated skin. Ultimately, the investigating authority requested withdrawal of the case from consideration under the wildlife protection act.

Kolipakam, V., Singh, S., Pant, B., Qureshi, Q., Jhala, Y. V. (2019). Genetic structure of tigers (Panthera tigris tigris) in India and its implications for conservation. Global Ecology and Conservation, 20, e00710. *https://doi.org/10.1016/j.gecco.2019.e00710*.

ABSTRACT

Identifying and prioritising naturally occurring within-species diversity, which may correlate with local adaptations or vicariance, is an integral part of conservation planning. Using non-invasive sampling and a panel of 11 microsatellites on 158 individual tigers from a pan India sample, our evaluation revealed three population clusters in India: unique North-Eastern tigers, a combined cluster of Western Ghats, Western India and Terai tigers, and a mixed cluster from Central India. At further population division, tigers from Odisha, Valmiki and southern Western Ghats were distinct. Central Indian tigers were most diverse, but showed the highest level of local structuring, suggestive of human induced fragmentation. We show that tigers

in India are genetically structured and some clusters are unique. Considering a combined analysis of population size, genetic diversity and uniqueness, tigers from the North-East hills, and southern Western Ghats emerge as conservation priorities.We propose reintroductions and supplementation of tigers be done among the same broad genetic clusters. Restoration and management of habitat corridors is vital for anthropogenically fragmented Central Indian populations. This study suggests a paradigm shift from indiscriminately doubling tiger numbers to prioritising conservation of naturally occurring diversity amongst tigers, to retain their full evolutionary potential, while managing to mitigate anthropogenic induced genetic structuring.

Mittal, P., Jaiswal, S. K., Vijay, N., et al. (2019). Comparative analysis of corrected tiger genome provides clues to its neuronal evolution. Scientific Reports, 9, 18459. *https://doi.org/10.1038/s41598-019-54838-z*.

ABSTRACT

The availability of completed and draft genome assemblies of tiger, leopard, and other felids provides an opportunity to gain comparative insights on their unique evolutionary adaptations. However, genome-wide comparative analyses are susceptible to errors in genome sequences and thus require accurate genome assemblies for reliable evolutionary insights. In this study, while analyzing the tiger genome, we found almost one million erroneous substitutions in the coding and non-coding region of the genome affecting 4,472 genes, hence, biasing the current understanding of tiger evolution. Moreover, these errors produced several misleading observations in previous studies. Thus, to gain insights into the tiger evolution, we corrected the erroneous bases in the genome assembly and gene set of tiger using 'SeqBug' approach developed in this study. We sequenced the first Bengal tiger genome and transcriptome from India to validate these corrections. A comprehensive evolutionary analysis was performed using 10,920 orthologs from nine mammalian species including the corrected gene sets of tiger and leopard and using five different methods at three hierarchical levels, i.e. felids, Panthera, and tiger. The unique genetic changes in tiger revealed that the genes showing signatures of adaptation in tiger were enriched in development and neuronal functioning. Specifically, the genes belonging to the Notch signalling pathway, which is among the most conserved pathways involved in embryonic and neuronal development, were found to have significantly diverged in tiger in comparison to the other mammals. Our findings suggest the role of adaptive evolution in neuronal functions and development processes, which correlates well with the presence of exceptional traits such as sensory perception, strong neuro-muscular coordination, and hypercarnivorous behaviour in tiger.

Thatte, P., Chandramouli, A., Tyagi, A., et al. (2019). Human footprint differentially impacts genetic connectivity of four wide-ranging mammals in a fragmented landscape. Diversity and Distributions, 26, 299–314. *https://doi.org/10.1111/ddi.13022*.

ABSTRACT

Aim: Maintaining connectivity is critical for long-term persistence of wild carnivores in landscapes fragmented due to anthropogenic activity. We examined spatial genetic structure and the impact of landscape features on genetic structure in four widespread species—jungle cat (Felis chaus), leopard (Panthera pardus), sloth bear (Melursus ursinus) and tiger (Panthera tigris). Location: Our study was carried out in the central Indian landscape, a stronghold in terms of distribution and abundance of large mammals. The landscape comprises fragmented forests embedded in a heterogeneous matrix of multiple land use types. Methods: Microsatellite data from non-invasively sampled individuals (90 jungle cats, 82 leopards, 104 sloth bears and 117 tigers) were used to investigate genetic differentiation. Impact of landscape features on genetic structure was inferred using a multimodel landscape resistance optimization approach. Results: All four study species revealed significant isolation by distance (IBD). The correlation between genetic and geographic distance was significant only over a short distance for jungle cat, followed by longer distances for sloth bear, leopard and tiger. Overall, human footprint had a high negative impact on gene flow in tigers, followed by leopards, sloth bears and the least on jungle cats. Individual landscape variables—land use, human population density, density of linear features and roads— impacted the study species differently. Although land use was found to be an important variable explaining genetic structure for all four species, the amount of variation explained, and the optimum spatial resolution and the resistance values of different land use classes varied. Main conclusions: As expected from theory, but rarely demonstrated using empirical data, the pattern of spatial autocorrelation of genetic variation scaled with dispersal ability and density of the study species. Landscape genetic analyses revealed species-specific impact of landscape features and provided insights into interactions between species biology and landscape structure. Our results emphasize the need for incorporating functional connectivity data from multiple species for landscapelevel conservation planning.

Tahoor, A., Khan, J.A., and Mahfooz, S. (2019). A comparative survey of microsatellites among wild and domestic cats provides valuable resources for marker development. Molecular Biology Reports, 46, 3025–3033. *https://doi.org/10.1007/s11033-019-04739-1*.

ABSTRACT

Information on the level and distribution of genetic variation is important for conservation plan of captive population of an endangered species such as tiger and cheetah. We assayed the

frequency of microsatellites in the genomic and genic sequences of wild cats (Panthera tigris, Acinonyx jubatus) and compared it with the domestic cat (Felis catus). Frequency, relative abundance and density of microsatellites were highest in the domestic cat when compared with wild cats. The frequency of microsatellites was positively correlated with the G+C content of genomic and genic sequences. The maximum frequency of microsatellites among all three sequence sets was of di-nucleotide repeats (genomic—88.1%; genic—70.4%), whereas the hexa-nucleotide repeat represents < 0.5%. Motif conservation study among the genomic and genic sequences revealed conservation of 81.3% and 51.0% motif within the members of family Felidae. A total 40,233 primers from genic sequences were designed in order to enrich the members of family Felidae with genomic resources. The designed primers could be useful in determining the molecular genetics of population structure and individualization of a particular cat.

MONITORING AND ASSESSMENT

Bajaj, S., Geraldine Bessie Amali, D. (2019). Species Environmental Niche Distribution Modeling for Panthera Tigris Tigris 'Royal Bengal Tiger' Using Machine Learning. In: Shetty, N., Patnaik, L., Nagaraj, H., Hamsavath, P., Nalini, N. (eds) Emerging Research in Computing, Information, Communication and Applications. Advances in Intelligent Systems and Computing, vol 882. Springer, Singapore. *https://doi.org/10.1007/978-981-13-5953-8_22*.

ABSTRACT

Biodiversity loss due to habitat degradation, exploitation of natural deposits, rapid change of environment and climate, and various anthropogenic phenomenon throughout the last few decades in the quest of development have led to rise in safeguarding species ecological domain. With natural habitat of the endangered Panthera Tigris Tigris fast declining, coupled with factors such as loss in genetic diversity and disruption of ecological corridors, there is an urgent need to conserve and reintroduce it to newer geographic locations. The study aims to predict and model the distribution of the species Panthera Tigris Tigris by combining various climatic, human influence, and environmental factors so as to predict alternate ecological niche for the already dwindling tiger habitats in India. 19 Bioclimatic variables, Elevation level, 17 Land Cover classes, Population Density, and Human Footprint data were taken. MAXENT, SVM, Random Forest, and Artificial Neural Networks were used for modeling. Sampling bias on the species was removed through spatial thinning. These variables were tested for Pearson correlation and those having coefficient greater than 0.70 were removed. Kappa statistic and AUC were used to study the results of the methodology implemented. Testing data comprises 25% of the presence only points and test AUC value of MAXENT was found to be the highest at 0.963, followed by RF at 0.931, ANN at 0.906, and lastly SVM at 0.898. These indicated a high

degree of accuracy for prediction. The most recent datasets were taken into consideration for the above variables increasing accuracy in both time and spatial domain.

Global Tiger Forum. (2019). Status of Tiger Habitats in High Altitude Ecosystems of Bhutan, India and Nepal: Situation Analysis.

ABSTRACT

Tiger habitats in high altitude require protection through sustainable land use, as they are a high value ecosystem with several hydrological and ecological processes providing ecosystem services and adaptation to mitigate the ill effects of climate change. Since several high-altitude habitats in South Asia have the spatial presence of tiger, active in-situ efforts are called for ensuring their conservation. The instant situation analysis study aims to provide the rationale for stepping up high altitude conservation of the tiger, while identifying possible viable habitats, corridor linkages, anthropogenic pressures, and induced landscape level changes for evolving an in-situ conservation roadmap. The study, led by the GTF, with range country governments of Bhutan, India and Nepal, along with conservation partners (WWF and country specific collaborators), has been supported by the Integrated Tiger Habitat Conservation Programme (ITHCP) of the IUCN and KfW.

Habib, B., Nigam P., Pallavi, G., Gomes, L., Praveen, N. R., Sinha, V., Ladkat, N. S., Guruprasad, G. and Bhagwat, S. (2019): Status of Tigers, Co-Predator and Prey in Tadoba Andhari Tiger Reserve (TATR) 2019. Wildlife Institute of India and Maharashtra Forest Department. TR. No. 2020/05 – Pp 47.

SUMMARY

The Phase IV monitoring for the TATR core and buffer was conducted from November – April 2019 as part of the project "Long Term Monitoring of Tigers, Co-Predators and Prey species in Tadoba-Andhari Tiger Reserve, Maharashtra India". The exercise aimed to cover an area of 1700 km^2 but excluding the areas with villages and inaccessible locations. The objective of the Phase IV Monitoring is to estimate the minimum number of tigers in the reserve using Capture-Recapture Sampling and density estimation of prey base using Distance Sampling. 359 camera traps were placed in the core and buffer area of TATR following a sampling grid of 2.01 sq. km in three blocks. In each sampling block camera traps were active for 25-30 days. 150 days of camera trapping survey with sampling effort of 31,000 trap nights yielded data used for further analysis. Tiger density per 100 km^2 based on Spatially Explicit Capture-Recapture (SECR) model was 5.23 in the Tadoba Andhari Tiger Reserve while that of Leopards based on the same method was 6.86. In order to estimate prey density, 20 line-transects in core area and 67

line transects in buffer area were sampled 3- 7 times during the sampling period, with a total walking effort of 280 km and 914 km in core and buffer area respectively. The overall density of major prey species as estimated using distance sampling was 18.67 (±2.42) /sq. km whereas it was 17.67 (±2.43)/sq. km in buffer and 30.11 (±4.26)/sq. km in core respectively. The density of major prey species in core were Sambar 6.22(±2.16); Chital 8.21 (±2.69); Gaur 2.19 (±1.09); Wild pig 3.92 (±1.43); Langur 10.58 (±5.69); Nilgai 1.43 (±0.95); Barking deer 1.19 (±0.38)) ; Black-naped hare 0.72 (±0.37);Peafowl 4.18 (±1.10) ; Jungle fowl 0.35 (±0.28) per sq. km. The density of major prey species in buffer were Sambar 1.87 (±0.27); Chital 6.16 (±1.43); Gaur 2.60 (±0.97); Wild pig 9.08 (±5.22); 8.45 (±51.23); Nilgai 0.86 (±0.25); Barking 0.25 (±0.09) ; Black-naped hare 0.54 (±0.17), Peafowl 0.69 (±0.28) ; Jungle fowl 0.29 (±0.07) per sq. km.

In order to study space use pattern and activity we used camera-trapping data from both core and buffer area of Tadoba-Andhari Tiger Reserve. Camera trap locations with number of captures of each species were modeled in a GIS domain using IDW (Inverse distance weighted) interpolation technique to generate spatially explicit capture surfaces. The times recorded on camera trap photos provide information on the period during the day that a species is most active. Species active at the same periods may interact as predator and prey, or as competitors. Sensors that record active animals (e.g. camera traps) build up a record of the distribution of activity over the course of the day. Records are more frequent when animals are more active and less frequent or absent when animals are inactive. The area under the distribution of records thus contains information on the overall level of activity in a sampled population.

Jhala, Y. V., Qureshi, Q., and Nayak, A. K. (Eds.). (2019). Status of tigers, co-predators and prey in India 2018: Summary report (TR No./2019/05). National Tiger Conservation Authority, Government of India, New Delhi and Wildlife Institute of India, Dehradun.

SUMMARY

India's national tiger assessment is the largest biodiversity survey being carried out anywhere in the world. The fourth cycle of the assessment was undertaken in 2018 and 2019 using the best available science, technology and analytical tools. In this cycle, recording of primary field data digitally through mobile phone application like M-STrIPES (Monitoring System for Tigers - Intensive Protection and Ecological Status), that uses GPS to geotag photo-evidences, and survey information made this exercise more accurate, with smaller margins of human error. Further, it involved the development of innovative technology like automated segregation of camera trap photographs to species using artificial intelligence and neural network models (software CaTRAT - Camera Trap data Repository and Analysis 6 Tool). Program ExtractCompare that fingerprints tigers from their stripe patterns was used to count the number of individual tigers (>1 year old). The unique feature of this cycle of assessment, in keeping up with "Digital

India", is the development and use of innovative technological tools in collection and processing of data to reduce human errors.

Verma, M., Tiwari C., Anand S., Edgaonkar, A., David, A., Kadekodi, G., Ninan K.N., Sharma P., Panda P.,Thatey .Z. (2019). Economic Valuation of Tiger Reserves in India: Phase II. Indian Institute of Forest Management. Bhopal, India.

ABSTRACT

The tiger reserves are repositories of natural ecosystems and biodiversity which emanate ecosystem services essential for human well-being. They continuously disseminate a range of economic, social, cultural and spiritual benefits. Tiger reserves as protected areas preserve the wilderness and natural systems which support ecological processes responsible for providing various goods and services. For instance, forests in tiger reserves aid in conserving the soil by preventing soil erosion and leaching of nutrients. They play an important role in the water cycle and other bio-chemical cycles, help in regulating the climate and balance of gases in the atmosphere, and help in mitigating disasters and protect the genetic diversity. Tiger reserves are beneficial not only at local but regional, national and even global scales. The study findings indicate that at different scales the flow of ecosystem matrix varies accordingly. Economic valuation helps in recognizing, demonstrating and capturing these values into the mainstream socio-economic system and policy making. These forests not only provide benefits for present direct and indirect use but also ensure the perpetuity of these benefits for future generations. The ecosystem service is an interdisciplinary approach to the integrative study of both socioeconomic and ecological systems. A proper understanding of the benefits in the form of ecosystem services from tiger reserves generates awareness and assists in assessing the trade-offs and strengthen the case for conservation of our natural heritage. The Centre for Ecological Services Management (CESM) at the Indian Institute of Forest Management (IIFM) executed the study entitled "Economic Valuation of Tiger Reserves in India: A Value+ Approach" commissioned by the National Tiger Conservation Authority (NTCA), during 2013-15. It was an attempt to showcase the value of nature's benefits and their immense contribution to people's well-being. The Phase-I Study (2013-15) conducted valuation in six tiger reserves in India — Corbett, Kanha, Kaziranga, Periyar, Ranthambore and Sundarbans, representing different tiger landscapes in the country, carried out a pilot study for application of spatial mapping tools for ecosystem service mapping and attempted to estimate the cost of recreating a tiger reserve. The study used scientific and objective parameters and peer-reviewed methodology along with a 'Value+' approach to conduct quantitative and qualitative assessment of 25 ecosystem services. While natural landscapes such as tiger reserves in all practicality can never be recreated, the study attempted to determine the cost of re-creation of a tiger reserve if inadequate protection to existing tiger reserves necessitate establishment of

new ones. Additionally, the study also demonstrated the application of InVEST– a suite of tools used for mapping ecosystem services. Recognizing the management and policy relevance of the work, extension of the study was suggested by NTCA and hence the second phase of the study was sanctioned to conduct economic valuation of ten additional tiger reserves and also improve upon the estimated values from the previous six tiger reserves. To accomplish the same, Phase-II of "Economic Valuation of Tiger Reserves in India" was assigned to CESM, IIFM by NTCA, which is the present study executed during 2016-19.

ZOOLOGY AND ANIMAL WELFARE

Boon, A., Kalaignan, P. A., Sridhar, K., Vairamuthu, S., and Jayathangaraj, M. G. (2019). Hematological and serum biochemical indices of captive Royal Bengal Tigers (Panthera tigris), Arignar Anna Zoological Park, Vandaloor, Chennai. Indian Journal of Animal Research, 53(12), 1613-1618. doi: 10.18805/ijar.B-3718.

ABSTRACT

The study on Hematological and serum biochemical indices of captive Royal Bengal Tigers (Panthera tigris) was carried out in tigers reared under the captive conditions at Zoo and Rescue centre of Arignar Anna Zoological Park, Vandalur of Tamil Nadu state (12.8781° N, 80.0859°E) from 2015 to April, 2017. Blood samples were collected from 30 tigers from lateral coccygeal vein during the routine clinical examination at squeeze cages in K-EDTA vials.The mean hematological values for Hemoglobin (g%), PCV (%), RBC (106/ µl) and WBC (103/ µl), were found to be 14.43±1.12 (g%), 48.10±0.49 (%)7.37±1.35 (106/ µl) 13.73±0.76 (103/ µl), respectively. Similarly, the mean±S.E. values of erythrocyte indices (MCV in fl, MCH in pg and MCHC in g/dL) were found to be 60.40±0.25 (fl), 32.56±0.34 (pg) and 54.56±0.35 (g/dl), respectively in these tigers investigated. The overall serum biochemical parameters like blood urea nitrogen BUN (mg/dL), creatinine (mg/dL), total protein (g/dL), albumin (g/dL), globulin (g/dL), ALT(IU/L), ALP(IU/L), calcium (mg/dL), phosphorous (mg/dL), cholesterol (mg/dL) and glucose (mg/dL) were estimated to be 43.43±0.55 mg/dL, 2.43±2.11 (mg/dL), 7.45±1.35 (g/dL), 3.08±2.33(g/dL), 2.74±2.28 (g/dL), 103.04±0.30 (IU/L), 78.10±0.40 (IU/L),10.57±1.11 (mg/dL), 8.66±1.30 (mg/dL), 151.83±0.27 (mg/dL) and 59.66±0.40 (mg/dL) respectively. The geographical and meteorological parameters were also assessed in this study. All other components were maintained as same for the tigers including feed and water.

Dharanesha, N. K., Saminathan, M., Mamta, P., et al. (2019). Parasitic pneumonia caused by Paragonimus spp. in a wild Royal Bengal Tiger, Mysuru, South India. Journal of Parasitic Diseases, 43, 528–533. *https://doi.org/10.1007/s12639-019-01112-8*.

ABSTRACT

Parasitic pneumonia induced by genus Paragonimus involves many species, which affects both humans and animals and it is a food borne zoonotic disease. In this report, we have described the gross and histopathological findings of Paragonimus fluke infection in lungs of tiger. The postmortem examination of sub adult male wild tiger (Panthera tigris tigris) died in captivity was conducted, earlier which was rescued by Forest Department, Mysuru, Karnataka, India. External examination of carcass revealed pale oral and conjunctival mucous membranes with sunken eye balls. During necropsy, moderate congestion, consolidation and numerous transparent to dark encysted lesions were found in the parenchyma of all lobes of lungs visible grossly on pleural surface. Lungs were hemorrhagic with necrotic foci around the cysts. The incision of encysted lesions revealed the presence of flukes (2–3 in numbers) in each cyst with brownish exudate. The lung tissues with lesions were collected in 10% formalin and haematoxylin and eosin staining was done for histopathological evaluation. The flukes were identified as Paragonimus spp. based on the morphology and micrometry. The histopathological examination revealed presence of longitudinal sections of flukes in bronchial lumen (in pair) with tegument and tegumental spines surrounded by connective tissue capsule as cystic encapsulation and numerous eggs in adjacent lung parenchyma. Necrosis and moderate fibrosis of lung parenchyma with infiltration of polymorphonuclear and mononuclear inflammatory cells were observed around fluke as well as eggs. The squamous cell metaplasia of lining bronchial epithelium and atelectasis of alveoli were also prominently seen.

Moudgil, A. D., Singla, L. D., Sharma, A., and Bal, M. S. (2019). First record of Toxoplasma gondii antibodiesin Royal Bengal tigers (Panthera tigris tigris) and Asiatic lions (Panthera leo persica) in India. Veterinaria italiana, 55(2), 157–162. *https://doi.org/10.12834/VetIt.971.5066.3*.

ABSTRACT

The purpose of this study was to detect the antibodies against Toxoplasma gondii in Royal Bengal tigers (Panthera tigris tigris), Asiatic lions (Panthera leo persica), leopards (Panthera pardus), and elephants (Elephas maximus indicus) residing in the Mahendra Chaudhury Zoological Park, in Chhatbir, Punjab (India) during winter and monsoon seasons. Using indirect ELISA, 20 serum samples were analysed during the winter season. Results indicated that 1 lion (5%) tested seropositive, and 3 tigers and 1 lion (20%) were considered suspect. During the monsoon, 4 individuals (2 tigers and 2 lions, 20%) were seropositive, whereas only 1 tiger (5%) gave suspected results. Significantly higher globulin, creatinine, blood urea nitrogen, phosphorus, and creatine kinase values were recorded in seropositive and suspected groups. Levels of albumin, glucose, calcium, sodium, and iron decreased significantly in the seronegative group. Results from sero-testing 40 rodents trapped in and around the park

depicted the presence of antibodies against Toxoplasma gondii in 1 individual. This study reveals the haemato-biochemical alterations in both seropositive and suspected wild felids for toxoplasmosis. Moreover, it provides the first serological evidence of T. gondii exposure in wild felids, notably Royal Bengal tigers and Asiatic lions, in India.

Naidenko, S. V., Berezhnoi, M. A., Kumar, V., and Umapathy, G. (2019). Comparison of tigers' fecal glucocorticoids level in two extreme habitats. PloS one, 14(4), e0214447. *https://doi.org/10.1371/journal.pone.0214447*.

ABSTRACT

Application of different antibodies and extraction methods results in a wide range of steroid metabolite concentrations obtained during noninvasive hormones monitoring. It makes regional comparisons of steroid concentration very difficult. We compared three methods for extraction of glucocorticoids metabolites in tiger feces to examine correct stress level in Bengal and Amur tigers in India and Russia respectively. The results obtained with three different extraction methods correlate with each other positively and significantly. The highest concentration of fecal glucocorticoids metabolites (FGCM) was found after the extraction of wet feces samples with 90% methanol. The level of FGCM was significantly higher in Bengal tigers in India than in Amur tigers in Russian Far East. The reasons might be related to tigers' density or anthropogenic pressure.

SUSTAINABLE SOLUTIONS AND TECHNOLOGY

Shanu, S., Idiculla, J., Qureshi, Q., Jhala, Y., Aggarwal, A., Dimri, P., and Bhattacharya, S. (2019). A graph theoretic approach for modelling tiger corridor network in Central India-Eastern Ghats landscape complex, India. Ecological Informatics, 50, 76-85.

ABSTARCT

Wildlife habitat corridors are components of landscapes, which facilitate the movement of organisms and processes between areas of intact habitat, and thus provide landscape corridor as well as serve as an ideal component to study and understand physiological ecology. Corridors are thus regions within a given landscape that generally comprise native vegetation, and connect otherwise fragmented, disconnected, noncontiguous wildlife habitat patches in the landscape. The purpose of designing corridors as a conservation strategy is primarily to counter, and to the extent possible, mitigate the impacts of habitat fragmentation and loss on the biodiversity of the landscape, as well as support continuance of land use for essential local and global economic activities in the region of reference. In this paper, we use game theory

and graph theory to model and design a wildlife corridor in the Central India – Eastern Ghats landscape complex, with tiger (Panthera tigris tigris) as the focal species. We construct a graph using the habitat patches supporting wild tiger populations in the landscape complex as vertices and the possible paths between these vertices as edges. A cost matrix is constructed to indicate the cost incurred by the tiger for passage between the habitat patches in the landscape (based on Shelford's Law of Tolerance), by modelling a two-person Prisoner's Dilemma game. A minimum spanning tree is then obtained by employing Kruskal's algorithm, which would suggest a feasible tiger corridor network for the tiger population within the landscape complex. Additionally, analysis of the graph is done using various centrality measures, in order to identify and focus on potentially important habitat patches, and their potential community structure. Correlation analysis is performed on the centrality indices to draw out interesting trends in the network.

Simlipal TR / Yashpal Rathore

INDONESIA

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Behaviour

Kusmarani, F. M., Sjahfirdi, L., and Sunarto, S. (2019). Application of digital ethogram in Sumatran tiger (Panthera tigris sondaica) behavioral observation at Ragunan Zoological Park. AIP Conference Proceedings, 2168(1), 020082. doi:10.1063/1.5132509

ABSTRACT

Observation of animal behavior is a major theme in zoology, often used as a baseline for other studies. To obtain accurate data, data collection process needs to be enhanced through the use of technology. BORIS (Behavioral observation research interactive software) is a digital ethogram software for data collection process in behavioral research. Through the use of BORIS, data collection process can be done in live observation and from video recording. In this study, the software was used to collect daily activity data of a Sumatran tiger (Panthera tigris sondaica) in Ragunan Zoological Park, Jakarta. The process began with arranging the basic ethogram and inputting the subject data. Afterwards, observation was conducted for 2 hours and 30 minutes outside the tiger enclosure. Observation yielded a recording of 10 behavior types out of 15 behavior types in the ethogram. Timestamp was shown in seconds with accuracy up to 0.001 seconds. Total of 400 observation points were made during the data recording. Results were displayed in the table with the option to export to other formats (e.g. Microsoft Excel Spreadsheet). Overall, the use of BORIS in live behavioral observation gave positive results towards the accuracy and efficiency of data collection process.

Ecology

Poor EE, Jati VIM, Imron MA, Kelly MJ (2019) The road to deforestation: Edge effects in an endemic ecosystem in Sumatra, Indonesia. PLoS ONE 14(7): e0217540. *https://doi.org/10.1371/journal.pone.0217540*.

ABSTRACT

Worldwide, roads are a main driver of deforestation and degradation as they increase forest access along the forest edge. In many tropical areas, unofficial roads go unreported and unrecorded, resulting in inaccurate estimates of intact forested areas. This is the case in central Sumatra, which boasts populations of critically endangered Sumatran elephants (Elephas

maximus sumatrensis), tigers (Panthera tigris sumatrae) and other endemic flora and fauna that make the area globally unique. However, maps do not reflect the reality of forest loss in the area. Here we present new maps from 2002 and 2016 of digitized and ground-truthed roads in one of Sumatra's unique lowland tropical protected areas, Tesso Nilo National Park. Using our newly created roads dataset, we examine the distribution of forest with respect to distance to roads. Our data show >2,400 km of roads within the national park in 2016 –nearly a 10-fold increase from roads known in 2002. Most forest (82–99%) within Tesso Nilo falls within 100 m, 500 m, and 1000 m of road edges. Length of road increased 157% and road density increased from 1.06 km/km^2 to 2.63 km/km^2 from 2002–2016. Our results suggest that this endemic ecosystem is facing substantial threat from roads and their associated impacts. Without swift management action, such as road closures and increased enforcements by park management, this ecosystem, and its endemic wildlife, could be lost. It is imperative that protected areas worldwide more rigorously consider roads and road effects on ecosystem fragmentation in their conservation plans.

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATIONS

Weiskopf, S., McCarthy, J., McCarthy, K., Shiklomanov, A., Wibisono, H., and Pusparini, W. (2019). The conservation value of forest fragments in the increasingly agrarian landscape of Sumatra. Environmental Conservation, 46(4), 340-346. doi:10.1017/S0376892919000195.

ABSTRACT

Destruction of tropical rainforests reduces many unprotected habitats to small fragments of remnant forests within agricultural matrices. To date, these remnant forest fragments have been largely disregarded as wildlife habitat, and little is known about mammalian use of these areas in Sumatra. Here, we conducted camera trap surveys (2285 trap-nights) within Bukit Barisan Selatan National Park and five surrounding remnant forest fragments during 2010–2013 and used species composition metrics to compare use. We found 28 mammal species in the protected forest and 21 in the fragments. The fragments harboured a subset of species found in the protected forest and several species not observed in the protected forest. Critically endangered species such as Sunda pangolin (Manis javanica) and Sumatran tiger (Panthera tigris sumatrae) were found in the forest fragments, along with species of conservation concern such as marbled cat (Pardofelis marmorata) and Asiatic golden cat (Pardofelis temminckii). The biodiversity found within the fragments suggests that these small patches of remnant forest may have conservation value to certain mammal species and indicates the importance of further research into the role these habitats may play in landscape-level, multispecies conservation planning.

Yultisman, Y., Azizah, M., and Wardoyo, S. (2019). Konservasi Ex-Situ Harimau Sumatera (Panthera Tigris Sumatrae) Di Tmr Jakarta. Jurnal Sains Natural, 9, 29. doi:10.31938/jsn.v9i1.190

ABSTRACT

Ex-situ conservation of Sumatran tigers (Panthera tigris sumatrae) in Ragunan wildlife park, Jakarta Sumatran tiger (Panthera tigris sumatrae) is one of the endemic species of Indonesia, which until now still live on the island of Sumatra. According to the International Conservation Agency, the existence of the animal is approaching extinction. Taman Marga Satwa Ragunan is one of Sumatran tiger conservation institution. The purpose of the research was to know the breeding of Sumatran tiger in Ragunan Wildlife Park conservation area, to know the proper conservation strategy for Sumatran tiger and to know Sumatran tiger activity ex-situ. The research was conducted at the Sumatran Tiger in Taman Marga Satwa Ragunan. Data were analyzed by descriptive analysis. Taman Marga Satwa Ragunan has made a proper effort in tiger conservation, this is marked by an increase in the Sumatran Tiger population.

GENETICS

Ashrifurrahman, F., Aqil, F., Cynthia, E., Simamora, S., Novarino, W., and Roesma, D. I. (2019). Characteristic of CO1 gene in "Bonita," one of the female tiger Panthera tigris sumatrae in East Sumatra. World Journal of Advanced Research and Reviews, 4(2), 43-48.

ABSTRACT

Based on the IUCN Red List, Panthera tigris sumatrae or Sumatran Tiger holds the status of Critical (Critically Endangered /CR) species with an estimated population of only 371 individuals in the wild. Illegal hunting and trade are one of the causes that led to population decline drastically. Conventional forensic investigation such as morphological data collection is difficult to do because the sample has been degraded or mixed with other animal body parts. DNA barcode is an actual method that utilizes DNA for species identification based on the gene markers of living things. DNA barcode usually uses a DNA nucleotide sequence of genes that is different between species and almost unchanged in that species. The gene is cytochrome oxidase subunit 1 (CO1). Here we report the results of the characterization of the CO1 gene for DNA barcoding from one of the Sumatran tigers with an individual identity called Bonita caught in Riau province and released after being rehabilitated. This research has been able to characterize the CO1 Bonita gene along 435 nucleotides. That length of the nucleotide can be used as a Bonita barcode with the change in the eighth amino acid, Leucine to Proline with the 23rd nucleotide mutation (CTG CCG). CO1 can distinguish individuals in intra-species,

which in the eighth amino acid from other Panthera tigris is Leucine. CO1 gene can differentiate between species analyzed in this study with genetic distances greater than 8.3%.

Insani, N. (2019). Identifikasi Species Dari Kulit Yang Diduga Harimau Jawa (Panthera Tigris Sondaica) Berdasarkan Sikuen Gen Cytochrome b [Thesis, Universitas Pendidikan Indonesia].

SUMMARY

The study aimed to identify suspected tiger skin samples from Java using molecular analysis. Despite initial suspicions that the skins belonged to the extinct Javan Tiger, analysis of the skin samples through mitochondrial DNA markers revealed they were from Bos javanicus (Javan Banteng), a species in the ox group (Familia Bovidae). The study contradicts the initial assumption, demonstrating that the skin samples did not belong to the Javan Tiger (Panthera tigris sondaica), reinforcing the ongoing concerns about illegal poaching impacting endangered species in Indonesia.

Yunus, M. A., Alim, N., Sumianto, S., and Subagyo, A. (2019). Keragaman Dan Distribusi Mammalia Di Taman Nasional Way Kambas, Sumatra Indonesia [Diversity and Distribution of Mammals in Way Kambas National Park, Sumatra, Indonesia]. Prosiding Seminar Nasional Sains, Matematika, Informatika Dan Aplikasinya, 2(4), 31-42.

SUMMARY

Way Kambas National Park, spanning 125,621.3 hectares in Lampung Province, serves as a crucial wildlife habitat. Since 1995, wildlife monitoring using camera traps has documented 38 mammal species across various orders. Among these, endangered species like the Sumatran tiger, Sumatran rhinoceros, Sumatran elephant, tapir, sun bear, and several wild cat species have been recorded. The park is divided into five zones managed under a zoning system, facilitating conservation and specific usage areas, including intensive use, conservation, and designated areas. Surveys involve camera trapping and on-foot monitoring, specifically noting and mapping the signs of the five charismatic Sumatran mammals classified as endangered by the IUCN. The distribution mapping from 2013-2015 indicates the presence of Sumatran tigers, elephants, bears, and tapirs across nearly all zones, with rhinoceroses primarily concentrated in the core zone, especially within forested areas.

MONITORING AND ASSESSMENT

Radinal; D. Kiswayadi; M. Akbar; T. Boyhaqi; D. W. Gumay. 2019. Monitoring species diversity using camera traps in Ulu Masen ecosystem, Aceh Province, Indonesia. IOP Conference Series: Earth and Environmental Science, 365 (1), 1-8.

ABSTRACT

Camera traps are increasingly used to remotely monitor the population and distribution of a variety of species, including a number of threatened and elusive species over large geographical areas, with little human intervention/disturbance. Between April and September 2017, we deployed 150 camera traps at 75 stations, with two camera traps at each station, to monitor species diversity in the Ulu Masen Ecosystem in Aceh, Indonesia. We identified a total of 33 species that included three 'Critically Endangered', one 'Endangered', nine 'Vulnerable', seven 'Near Threatened' and 13 'Least Concern' species over 121 days with a total of 554 trap night/100 km^2 and Relative Abundance Index (RAI) of 51.93 frames/100 trap nights. Critically endangered species recorded included Panthera tigris sumatrae (three individuals and 17 independent photos), Elephas maximus sumatranus (17 independent photos), and Manis javanica (one independent photo), while Cuon alpinus was the only endangered species (EN) recorded. Our results indicate that the Ulu Masen still harbours a variety of rare and elusive species that need to be protected. Deriving reliable abundance estimates and distribution especially for rare and endangered species from camera traps is an important step in conservation and can be used to guide the management of these ecologically valuable species.

ZOOLOGY AND ANIMAL WELFARE

Saab, R., Siregar, P. G., and Setia, T. M. (2019). An Implementation of animal welfare in tiger sanctuary, Barumun Nagari Wildlife Sanctuary, North Sumatra, Indonesia. Biodiversitas Journal of Biological Diversity, 20(10).

ABSTRACT

Saab R, Siregar PG, Tatang Mitra Setia TM. 2019. Implementation of animal welfare in tiger sanctuary, Barumun Nagari Wildlife Sanctuary, North Sumatra, Indonesia. Biodiversitas 20: 2790-2795. The accelerated growth in the development of economic and social infrastructure has drastically diminished the population of Sumatran tiger (Panthera tigris sumatrae) and its habitat. As a result, conflicts between tigers and humans are increasing rapidly in recent years. The wild tigers in conflict, such as those that attack humans and livestock, are usually killed or captured, while those who cannot return to the forest due to injury or illness are then

translocated to the zoo. The increasing number of human and tiger conflicts raises the need for special facilities, such as sanctuaries, to recover the condition of the tigers, before they are released to the wild. This study aimed to examine the aspects of welfare management and assess the level of welfare of the tigers kept in the sanctuary at the Barumun Nagari Wildlife Sanctuary (BNWS) in North Sumatra, Indonesia. The study was carried out from March to April 2019, while data collection was carried out by literature studies, field observation on implementation of five animal welfare parameters, and self-assessment by the manager of the sanctuary. The results showed that, on a score from 1 to 5, the animal welfare parameter scores were 4.88 (freedom from hunger and thirst), 4.81 (freedom to express natural behavior), 4.79 (freedom from discomfort), 3.81 (freedom from fear and distress) and 3.69 (freedom from pain, injuries, and diseases). The total achievement implementation value of animal welfare in BNWS was 89.13, or very good. However, some improvements still have to be made by the sanctuary manager to enhance the animal welfare of tigers in BNWS.

Sudhir Mishra

LAO PDR

MONITORING AND ASSESSMENT

Rasphone, A., Kéry, M., Kamler, J. F., and Macdonald, D. W. (2019). Documenting the demise of tiger and leopard, and the status of other carnivores and prey, in Lao PDR's most prized protected area: Nam Et - Phou Louey. Global Ecology and Conservation, 20, e00766.

ABSTRACT

The Nam Et - Phou Louey National Protected Area (NEPL) is known for its diverse community of carnivores, and a decade ago was identified as an important source site for tiger conservation in Southeast Asia. However, there are reasons for concern that the status of this high priority diverse community has deteriorated, making the need for updated information urgent. This study assesses the current diversity of mammals and birds in NEPL, based on camera trap surveys from 2013 to 2017, facilitating an assessment of protected area management to date. We implemented a dynamic multispecies occupancy model fit in a Bayesian framework to reveal community and species occupancy and diversity. We detected 43 different mammal and bird species, but failed to detect leopard Panthera pardus and only detected two individual tigers Panthera tigris, both in 2013, suggesting that both large felids are now extirpated from NEPL, and presumably also more widelythroughout Lao PDR. Mainland clouded leopard Neofelis nebulosa had the highest estimates of probability of initial occupancy, persistence and colonization, and appeared to be the most widely distributed large carnivore, followed by dhole Cuon alpinus. Both of these species emerge as a priority for further monitoring and conservation in the NEPL landscape. This study provides the most recent assessment of animal diversity and status in the NEPL. Our analytical approach provides a robust and flexible framework to include sparse and inconsistent data sets of multiple species to assess their status via occupancy as a state process, which can often provide insights into population dynamics.

MYANMAR

MONITORING AND ASSESSMENT

Naing, H., Ross, J., Burnham, D., Htun, S., and Macdonald, D. (2019). Population density estimates and conservation concern for clouded leopards Neofelis nebulosa, marbled cats Pardofelis marmorata and tigers Panthera tigris in Htamanthi Wildlife Sanctuary, Sagaing, Myanmar. Oryx, 53(4), 654-662. doi:10.1017/S0030605317001260.

ABSTRACT

The clouded leopard Neofelis nebulosa is a potent ambassador species for conservation, occurring from the Himalayan foothills eastwards to Indochina, between which Myanmar is a biogeographical land bridge. In Myanmar's Northern Forest Complex, the species co-occurs with the tiger Panthera tigris, leopard Panthera pardus, marbled cat Pardofelis marmorata, golden cat Catopuma temminckii and leopard cat Prionailurus bengalensis. We deployed cameras within the Htamanthi Wildlife Sanctuary over 2 consecutive years. In 2014-2015 we deployed 82 camera stations around the Nam Pa Gon stream (Catchment 1) for 7,365 trap days. In 2015–2016 we deployed 80 camera stations around the Nam E Zu stream (Catchment 2) for 7,192 trap days. In Catchment 1 we identified five tigers from 26 detections, five clouded leopards from 41 detections (68 photographs) and 11 marbled cats from 13 detections. Using Bayesian-based spatial capture–recapture we estimated the densities of tigers and clouded leopards to be 0.81 ± SD 0.40 and 0.60 ± SD 0.24 individuals per 100 square km, respectively. In Catchment 2 we identified two tigers from three detections, nine clouded leopards from 55 detections and 12 marbled cats from37 detections.Densities of clouded leopards and marbled cats were 3.05 ± SD 1.03 and 8.80 ± SD 2.06 individuals per 100 square km, respectively. These differences suggest that human activities, in particular gold mining, are affecting felid populations, and these are a paramount concern in Htamanthi. We demonstrate the importance of Htamanthi within the Northern Forest Complex and highlight the Yawbawmee corridor as a candidate for protection.

NEPAL

HUMAN WILDLIFE INTERACTION AND CONFLICT MITIGATION

Bhattarai, B. R., Wright, W., Morgan, D., et al. (2019). Managing human-tiger conflict: lessons from Bardia and Chitwan National Parks, Nepal. European Journal of Wildlife Research, 65(3), 34. *https://doi.org/10.1007/s10344-019-1270-x*

ABSTRACT

Successful conservation outcomes for the tiger (Panthera tigris) have been achieved in Nepalese protected areas. However, an unwelcome consequence of greater tiger numbers is the increased prevalence of human-tiger conflict (HTC), particularly in buffer zone areas adjacent to key tiger reserves, which are heavily utilised by farming communities. HTC events may manifest as attacks by tigers on livestock or people, or as people harming tigers. Since 1994, 12 and 99 fatal tiger attacks on people were reported in and near Bardia and Chitwan National Parks, respectively; and since 1979, 34 tigers from these Parks have been killed due to HTC. HTC presents major threats to local people and to the continuing success of tiger

Rathika Ramasamy

conservation programmes. Conservation authorities in Nepal are implementing innovative solutions to prevent and mitigate HTC. These include financial compensation for damage caused by tigers and locally based community projects and programmes focussed on changing livestock husbandry practises, raising awareness of tiger ecology among local residents and supporting families to reduce their reliance on park resources. While these approaches have been successful in mitigating HTC and its effects in Nepal, further developments and refinements are required. This paper provides a synthesis of published and unpublished reports of HTC, in order to demonstrate the magnitude of the problem faced in Nepal. A critical summary of current management practises adopted in two of Nepal's key tiger reserves is intended to provide a tool for managers to target their efforts towards methods likely to achieve success.

Upadhaya, S. K. (2019). Human-wildlife interactions in the Western Terai of Nepal. [PhD Thesis], Universiteit Leiden, Netherlands.

ABSTRACT

Large carnivores and humans, along with their livestock, have co-existed for thousands of years. However, human population growth and an increase in economic activities are modifying the landscape for large carnivores and their prey. I studied the interaction between tiger and leopard in a human dominated landscape around Bardia National Park, Nepal. Due to the increase in number of tigers inside the park leopards may be pushed out of the park, where they become involved in conflicts while there may also be a spill-over of young tigers moving to the buffer zone. Tigers were not directly involved in conflict with people which were found from the presence of prey remains in their scats. Elephants were killing most of the humans whereas leopards were found to kill most of the livestock. For future conservation programs we need to focus on the conservation of tiger and leopard in human dominated landscape. Due to interaction with tigers, the leopards are living in close proximity with people and thereby get more involved in conflicts with local communities. Tigers enjoy a religious and cultural tolerance among the people living in the buffer zone whereas leopards lack such religious and cultural tolerance.

CONSERVATION, MANAGEMENT AND POLICY RECOMMENDATION

Bhandari, S., Shrestha, U. B., and Aryal, A. (2019). Increasing tiger mortality in Nepal: A bump in the road?. Biodiversity and Conservation, 28(15), 4115–4118. *https://doi.org/10.1007/s10531-019-01849-x*.

ABSTRACT

Tiger populations in Nepal increased from 121 in 2009 to around 235 in 2018 (Jaznkya 2018). If this trend continues, Nepal could be the first country to double its national tiger population under the T × 2 goal of doubling the world's tiger population by 2022 set at the World Tiger Submit in 2010 in St Petersburg, Russia. Despite some doubts in the number of tigers estimated and criticism with the questionable census method (Dixit 2018; Karanth et al. 2011), the reported increase brings optimism for the future of this endangered species, and for Nepal's conservation success. Changes in tiger conservation policies and programmes, the establishment of a new protected area, control of illegal hunting and poaching, and increased private funding and capacity building are regarded as major contributing factors for the increase in the tiger population (Karki et al. 2011; GON 2013; Dixit 2018). Despite this success, the challenges of tiger conservation in Nepal have increased considerably even in the face of increased tiger mortality which exacerbates the problem.

We examined the tiger mortality in Nepal from 2009 to 2018 by collecting data from newspaper reports, published and unpublished reports from governmental and non-governmental organizations. We also documented the date and location of death, age, sex, and cause of death. Our search was limited to casualties inside protected areas, including the buffer zones where the majority of tigers persist in Nepal. We then compared our results with the national tiger census.

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Ecology

Carter, N. H., Levin, S. A., and Grimm, V. (2019). Effects of human-induced prey depletion on large carnivores in protected areas: Lessons from modeling tiger populations in stylized spatial scenarios. Ecology and Evolution, 9, 11298–11313. *https://doi.org/10.1002/ece3.5632*.

ABSTRACT

Prey depletion is a major threat to the conservation of large carnivore species globally. However, at the policy-relevant scale of protected areas, we know little about how the spatial distribution of prey depletion affects carnivore space use and population persistence. We developed a spatially explicit, agent-based model to investigate the effects of different human-induced prey depletion experiments on the globally endangered tiger (Panthera tigris) in isolated protected areas—a situation that prevails throughout the tiger's range. Specifically, we generated 120 experiments that varied the spatial extent and intensity of prey depletion across a stylized

(circle) landscape (1,000 km²) and Nepal's Chitwan National Park (~1,239 km²). Experiments that created more spatially homogenous prey distributions (i.e., less prey removed per cel but over larger areas) resulted in larger tiger territories and smaller population sizes over time. Counterintuitively, we found that depleting prey along the edge of Chitwan National Park, while decreasing tiger numbers overall, also decreased female competition for those areas, leading to lower rates of female starvation. Overall our results suggest that subtle differences in the spatial distributions of prey densities created by various human activities, such as natural resource-use patterns, urban growth and infrastructure development, or conservation spatial zoning might have unintended, detrimental effects on carnivore populations. Our model is a useful planning tool as it incorporates information on animal behavioral ecology, resource spatial distribution, and the drivers of change to those resources, such as human activities.

Kafleya, H., Lamichhanec, B. R., Maharjand, R., Khadkae, M., Bhattaraif, N., and Gompperaa, M. E. (2019). Tiger and leopard co-occurrence: Intraguild interactions in response to human and livestock disturbance. Basic and Applied Ecology, 40, 78-89.

ABSTRACT

Intraguild interactions have important implications for carnivore demography and conservation. Differences in how predators respond to different forms of disturbance might alter their interaction patterns. We sought to understand how human and livestock disturbance impact co-occurrence of sympatric large carnivores such as tiger (Panthera tigris) and leopard (P. pardus) and thereby mediate the intraguild interaction pattern to enable coexistence of the species in a human-dominated landscape. We surveyed 361 locations in Chitwan National Park, Nepal, to examine how prey abundance and disturbance factors such as human and livestock presence might influence habitat use by tigers and leopards independently and when co-occurring. Single-species single-season models and two-species single-season models were developed to examine hypotheses on unconditional detection and occupancy and species interaction respectively. Pervasive human use of the park had negative impacts on tiger occupancy while the abundance of prey had a positive influence. Despite significant prey overlap between tigers and leopards, none of the native prey species predicted leopard habitat occupancy. However, habitats used extensively by livestock were also used by leopards. Further, we found strong evidence of intraguild competition. For instance tiger occupancy was higher in prey-rich areas and leopard occupancy was low in the sites where tigers were present. These findings, and a species interaction factor of < 1 clearly indicate that leopards avoid tigers, but their use of areas of disturbance enables them to persist in fringe habitats. We provide empirical evidence of how intraguild interaction may result in habitat segregation between competing carnivores, while also showing that human and livestock use of the landscape create disturbance patterns that facilitate co-occurrence of the predators. Thus, because large carnivores compete, some disturbance may mediate coexistence in small protected areas. Understanding such interactions can help address important conservation challenges associated with maintaining diverse carnivore communities in small or disturbed landscapes.

Lamichhane, B. R., Leirs, H., Persoon, G. A., et al. (2019). Factors associated with co-occurrence of large carnivores in a human-dominated landscape. Biodiversity and Conservation, 28, 1473–1491. *https://doi.org/10.1007/s10531-019-01737-4*.

ABSTRACT

We investigated the factors facilitating co-occurrence of two large carnivores, tigers (Panthera tigris) and common leopards (Panthera pardus), within a human-dominated landscape. We estimated their density and population size using camera-trap photographs and examined spatial segregation of habitats, temporal activity pattern, and diets in Chitwan National Park, Nepal. A Bayesian spatially-explicit capture-recapture model estimated densities of 3.2–4.6 (3.94 ± 0.37) tigers and 2.6–4.1 (3.31 ± 0.4) leopards per 100 km² with abundance of 70–102 tigers and 66–105 leopards. Tigers occupied the prime habitats (grasslands and riverine forests) in alluvial floodplains of the Park whereas leopards appeared in Sal forests and marginal areas where livestock are present. Both tigers and leopards showed crepuscular activity patterns with a high overlap but tigers were less active during the day compared to leopards. Leopards' activity in the day increased in the presence of tigers. Tiger and leopard diet overlapped considerably (90%). Compared to leopards, tigers consumed a higher proportion of the large prey and a smaller proportion of livestock. Our study demonstrates that sympatric large carnivores can coexist in high densities in prey rich areas that contain a mosaics of habitats. To increase the resilience and size of the Chitwan carnivore population, strategies are needed to increase prey biomass and prevent livestock depredation in adjacent forests. Long-term monitoring is also required to obtain a detailed understanding of the interaction between the large carnivores and their effects on local communities living in forest fringes within the landscape.

Pokheral, C. P., and Wegge, P. (2019). Coexisting large carnivores: Spatial relationships of tigers and leopards and their prey in a prey-rich area in lowland Nepal. Écoscience, 26(1), 1-9. *https://doi.org/10.1080/11956860.2018.1491512*.

ABSTRACT

In the Shuklaphanta National Park (Nepal), we sampled the spatial distributions and diel activity patterns of tigers and leopards during three winter (dry) seasons. Densities of both predators were similar and rather low (≤ 3/100 km²), but total prey base was high (> 150 animals/km²).

From camera trapping, 20 different tigers and leopards were identified. While leopards (9) were confined to areas along the reserve border, tigers (11) were located significantly farther inside, where the abundance of large-sized wild prey was higher and that of small-sized prey lower than closer to the border. In the inter-specific spatial overlap zones, the two species were never photographed at the same locations. Diel activity patterns did not differ. Normally, leopards avoid tigers owing to social interference. In our study, the spatial segregation was interpreted to be due to low predator-prey ratios (e.g., food not limiting for either species), with each species distributed in areas with highest densities of their preferred prey. Social interference behavior-although probably occurring-played a minor role. The concentration of leopards along the reserve border, coupled with a diet that included domestic dogs, suggest that different behavioral adaptations to anthropogenic factors might also have played a role.

MONITORING AND ASSESSMENT

Kafley, H., Lamichhane, B. R., Maharjan, R., et al. (2019). Estimating prey abundance and distribution from camera trap data using binomial mixture models. European Journal of Wildlife Research, 65, 77. *https://doi.org/10.1007/s10344-019-1308-0*.

ABSTRACT

Measures of absolute animal abundance may be estimated by capture-recapture, removal, or distance sampling methods. We investigate the usage of binomial mixture models to estimate local group abundance of major prey species that is frequently used as a surrogate for prey abundance to study predator or prey-mediated ecological interactions such as predator-prey relationships. We evaluate mixture models using data from a camera-trapping survey intended for a tiger Panthera tigris census in Chitwan National Park, Nepal, where the entire park was surveyed in 361 4-km^2 quadrats. We chose four prey species (chital Axis axis, sambar Rusa unicolor, muntjac Muntiacus muntjac, and wild boar Sus scrofa) that collectively account for > 75% of prey biomass consumed by tigers. Abundance of prey group was modeled as a random variable with a Poisson or a negative binomial distribution, with the mean abundance affected by distance from water sources, elevation, and normalized difference vegetation index (NDVI). Except for wild boar, the top models for all other species included the hypothesized covariates while the null model was the most parsimonious model for the wild boar. The most parsimonious chital model included effects of distance from water sources (−) and elevation (−). The sambar model supported all three covariates: distance from water sources (−), elevation (+), and NDVI (+). Only distance from water sources (−) was supported by the most parsimonious muntjac model. Our abundance estimates also conformed to the results obtained from recently conducted labor-intensive distance sampling procedure. We conclude that camera-trapping survey data can be effectively utilized adopting the binomial mixture model framework to understand animal abundance-habitat relationships and estimate abundance of animal that are not identifiable individually.

HUMAN WILDLIFE INTERACTION AND CONFLICT MITIGATION

Bhandari, K., Haque, I. B., Khanal, B., Joshi, S., and Khatri, K. S. (2019). Maxillofacial injuries in bear, tiger, and jackal attacks. Craniomaxillofacial Trauma and Reconstruction Open, 3(1). *https://doi.org/10.1055/s-0039-1678671*

ABSTRACT

Maxillofacial injuries as a result of wild animals attack are not commonly encountered and reported in the literature. Factors such as increasing human population near forest and lack of dependable physical barriers between forest and human habitations lead to frequently encountered incidents of wild animal attacks over humans especially in far western region of Nepal. The authors present two cases of bear attacks, one case of tiger attack, and one case of jackal attack and explain the pattern of maxillofacial injuries encountered along with management strategies undertaken. It was observed that the primary site of attacks of these wild animals was facial region. The magnitude of force with which bears and tigers attack over facial region with their paws can cause significant skeletal injuries irrespective of soft tissue injuries.

ZOOLOGY AND ANIMAL WELFARE

Karmacharya D, Manandhar P, Manandhar S, Sherchan AM, Sharma AN, et al. (2019) Gut microbiota and their putative metabolic functions in fragmented Bengal tiger population of Nepal. PLOS ONE 14(8): e0221868. *https://doi.org/10.1371/journal.pone.0221868*.

ABSTRACT

Bengal tigers (Panthera tigris tigris) serve a pivotal role as an apex predator in forest ecosystems. To increase our knowledge on factors impacting the viability and health of this endangered species, we studied the gut microbiota in 32 individual Bengal tigers from three geographically separated areas (Chitwan National Park (CNP), Bardia National Park (BNP) and Suklaphanta Wildlife Reserve (SWR)) in Nepal, using noninvasive genetic sampling methods. Gut microbiota influence the immune system, impact various physiological functions, and modulates metabolic reactions, that ultimately impact the host health, behavior and development. Across the tiger populations in Nepal, we found significant differences in the composition of microbial communities based on their geographic locations. Specifically, we detected significant

differences between CNP and the other two protected areas (CNP vs BNP: pseudo t = 1.944, P = 0.006; CNP vs SWR: pseudo t = 1.9942, P = 0.0071), but no differences between BNP and SWR. This mirrors what has been found for tiger gene flow in the same populations, suggesting gut microbiota composition and host gene flow may be linked. Furthermore, predictive metagenome functional content analysis (PICRUSt) revealed a higher functional enrichment and diversity for significant gut microbiota in the Chitwan tiger population and the lowest enrichment and diversity in Suklaphanta. The CNP tiger population contained higher proportions of microbiota that are associated with predicted functions relevant for metabolism of amino acid, lipid, xenobiotics biodegradation, terpenoides and polyketides than the SWR population. We conclude the tiger population structure, gut microbiota profile and associated functional metabolic categories are correlated, with geographically most separated CNP and SWR tiger population having the most distinct and different host genotype and microbiota profiles. Our work dramatically expands the understanding of tiger microbiota in wild populations and provides a valuable case study on how to investigate genetic diversity at different hierarchical levels, including hosts as well as their microbial communities.

Ayan Sadhu

RUSSIA

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Behaviour

Antonenko, T., Matsyura, A., and Pysarev, S. (2019). Influence of Cinnamon on the behavior of Amur Tiger (Panthera tigris altaica, Temminck, 1844) in captivity. Ukrainian Journal of Ecology, 9, 332-334. *https://doi.org/10.15421/2019_100*.

ABSTRACT

Our primary interest is in welfare of Amur tiger (Panthera tigris altaica, Temminck, 1844) in the Barnaul Zoo and Leningrad Zoo. As discussed below, behavioral researches can reveal much about the welfare of captive wild animals. Amur tiger s behavior is studied and time budget is calculated for males and females. The Schorygin' similarity coefficient of behavior is determined (82.64% and 86.76%). We analyzed the differences in their behavior before and after olfactory enrichment. Cinnamon oil reduces pacing, sheltering, sleep and rest time, play behavior, increases exploratory behavior in 50% of researched Amur tigers. The reaction time of the flemen increased in both males. Younger animals better perceived olfactory enrichment. Stereotypical behavior (pacing) have decreased in post-enrichment day.

Marcel Langthim from Pixabay

MONITORING AND ASSESSMENT

Petrunenko, Y.K., Seryodkin, I.V., Bragina, E.V., et al. (2019). How does a tigress balance the opposing constraints of raising cubs? Mammal Research, 65, 245–253. *https://doi.org/10.1007/s13364-019-00466-x*.

ABSTRACT

The persistence of wildlife populations largely depends on females successfully rearing young through the earliest, most vulnerable period. During this period, mothers must balance the costs of home range maintenance, food acquisition, and protection of cubs. We monitored a GPS-collared Amur tigress Panthera tigris altaica for 4 months prior to and 4 months after giving birth to assess how home range size, activity budget, movements, and hunting behavior changed between these periods. After birth, home range size collapsed as activities were centered around the den site. With cubs, the tigress spent slightly less time moving, but greatly increased the rate at which she traveled. Kill rate, handling time, and daily consumption rates did not change significantly, but there was an indication that larger prey were killed during the natal denning period than in other periods. When cubs left the den site and started travelling with their mother, the female was able to increase time spent with cubs, reducing risk of predation. We hypothesize that some of the behaviors of this tigress, which appeared likely to increase cub survival, may be universal across the species, but others will be dependent on ecological parameters specific to the site.

minka2507 from Pixabay

THAILAND

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Duangchatrasiri, S., Jornburom, P., Jinamoy, S., et al. (2019). Impact of prey occupancy and other ecological and anthropogenic factors on tiger distribution in Thailand's western forest complex. Ecology and Evolution, 9, 2449–2458. *https://doi.org/10.1002/ece3.4845*.

ABSTRACT

Despite conservation efforts, large mammals such as tigers (Panthera tigris) and their main prey, gaur (Bos gaurus), banteng (Bos javanicus), and sambar (Rusa unicolor), are highly threatened and declining across their entire range. The only large viable source population of tigers in mainland Southeast Asia occurs in Thailand's Western Forest Complex (WEFCOM), an approximately 19,000 km^2 landscape of 17 contiguous protected areas. We used an occupancy modeling framework, which accounts for imperfect detection, to identify the factors that affect tiger distribution at the approximate scale of a female tiger's home range, 64 km^2, and site use at a scale of 1-km^2. At the larger scale, we estimated the proportion of sites at WEFCOM that were occupied by tigers; at the finer scale, we identified the key variables that influence site-use and developed a predictive distribution map. At both scales, we examined key anthropogenic and ecological factors that help explain tiger distribution and habitat use, including probabilities of gaur, banteng, and sambar occurrence from a companion study. Occupancy estimated at the 64-km^2 scale was primarily influenced by the combined presence of all three large prey species, and 37% or 5,858 km^2 of the landscape was predicted to be occupied by tigers. In contrast, site use estimated at the scale of 1 km^2 was most strongly influenced by the presence of sambar. By modeling occupancy while accounting for imperfect probability of detection, we established reliable benchmark data on the distribution of tigers in WEFCOM. This study also identified factors that limit tiger distributions; which managers can then target to expand tiger distribution and guide recovery elsewhere in Southeast Asia.

Saisamorn, A., et al. (2019). Spatial and temporal analysis of leopards (Panthera pardus), their prey and tigers (Panthera tigris) in Huai Kha Khaeng Wildlife Sanctuary, Thailand. Folia Oecologica, 46, 73-82.

ABSTRACT

Despite their extensive distribution globally, recent reports indicate leopards are declining, especially in Southeast Asia. To support conservation efforts we analyzed the behavioral interactions between leopards (Panthera pardus), their prey, and tigers to determine if leopards

fine-tune their activity to maximize contact with four prey species (sambar; wild boar; barking deer; banteng) and avoid tigers and if prey alter their temporal activity in response to variation in their relative abundance ratio with leopards. A lower density of sambar in the northern part of our study area and a lower density of wild boar and a higher density of tigers in the southern part allowed us to examine fine-grained differences in the behavior of leopards and their prey. We used camera trap data to investigate spatial and temporal overlap. Differences in tiger relative abundance did not appear to impact the temporal activity of leopards. Leopards had similar cathemeral activity at all sites with highest activity at dawn and dusk. This behavior appears to be a compromise to provide access to diurnal wild boar and barking deer and nocturnal sambar and banteng. Sambar showed higher temporal avoidance of leopards in the north where its RAI was lowest; in contrast, wild boar had the highest temporal avoidance in the south where its density was lowest. This is the first study in Southeast Asia to quantify spatial and temporal interactions between the leopard, its primary ungulate prey, and the tiger. It provides new insights for conserving this declining subspecies.

MONITORING AND ASSESSMENT

Ngoprasert, D., and Gale, G. A. (2019). Tiger density, dhole occupancy, and prey occupancy in the human disturbed Dong Phayayen – Khao Yai Forest Complex, Thailand. Mammalian Biology, 95, 51-58. *https://doi.org/10.1016/j.mambio.2019.02.003*.

ABSTRACT

Large carnivores have been declining due to a combination of factors including habitat loss and fragmentation, prey loss, and direct persecution. Tiger Panthera tigris and dhole Cuon alpinus are endangered and emblematic of problems facing large carnivores globally. We estimated tiger density, dhole occupancy and prey availability within the Dong Phayayen - Khao Yai Forest Complex, a World Heritage Area in Thailand that has potential as a 'recovery site' for both species. Camera traps were set near bait stations designed for bear monitoring. A Bayesian spatial capture-recapture approach was used to estimate tiger density and occupancy of dhole and their prey. Camera traps were deployed in two areas, Khao Yai (78 locations, December 2009-May 2011) and Dong Phayayen (45 locations, December 2012-August 2014). Tiger was not detected in Khao Yai. We detected 9 tigers (2 male, 4 females, and 3 unknown sex) in Dong Phayayen. Tiger density was 2.1 (95% CI 0.5–5.3) individuals per 100 km^2 based on an individual heterogeneity model. Dhole occupancy was higher in Khao Yai (64%) than Dong Phayayen (55%). Prey occupancy was 9–53% higher in Dong Phayayen. Wild pig Sus scrofa had the highest occupancy rates, followed by gaur Bos gaurus, sambar Rusa unicolor and muntjac Muntiacus muntjac, respectively. Although Dong Phayayen's tiger density was lower compared to populations estimated in some better-known protected areas, our data suggest

it has potential as a regional tiger (and perhaps dhole) recovery site. However, Dong Phayayen, like many sites in the region, faces significant threats from wildlife hunting and rosewood (Dalbergia spp.) poaching that need to be addressed urgently if this small population is going to survive even the near term.

ZOOLOGY AND ANIMAL WELFARE

Areewong, C., Sangchantip, R., Rungphattanachaikul, S., Rittipornlertrak, A., Fhaikruae, I., Wongkalasin, W., Nomsiri, R., Boontong, P., Vongchan, P., and Sthitmatee, N. (2019). Production and characterization of polyclonal antibody against Bengal tiger (Panthera tigris tigris) immunoglobulin G. Journal of Applied Animal Research, 47(1), 289-296. *https://doi.org/10.1080/09712119.2019.1629937*.

ABSTRACT

Despite increasing opportunities for tigers to be exposed to emerging diseases due to global changes coupled with increasing interaction with humans, there is no available antibody specific to tigers. Aims of this study were to produce a rabbit anti-Bengal tiger (Panthera tigris tigris) IgG polyclonal antibody and to determine its specificity. The molecular weight of the purified Bengal tiger IgG was approximately 170 kDa. The cross-reactivity of rabbit anti-Bengal tiger IgG to IgG of other wild felid species and other domestic animals was analyzed by indirect enzyme-linked immunosorbent assay. The cross reactivity to other related wild animals ranged from 53.69% to 75.63%. There was high crossreactivity with domestic cats (63.58%) and pigs (38.45%) and low cross-reactivity with domestic cows (10.46%), goats (8.60%), sheep (7.25%), and chickens (6.91%). To confirm cross-reactivity with domestic animals' IgG, western blotting was performed. These results indicated that the purified rabbit anti- Bengal tiger IgG polyclonal antibody strongly reacted with species in the family Felidae. The polyclonal antibody generated in this study has the potential to aid in the development of useful tools for further novel immunological investigations on tigers and related felid species.

Sangkachai, N., Thongdee, M., Chaiwattanarungruengpaisan, S., Buddhirongawatr, R., Chamsai, T., Poltep, K., Wiriyarat, W., and Paungpin, W. (2019). Serological evidence of influenza virus infection in captive wild felids, Thailand. The Journal of Veterinary Medical Science, 81(9), 1341–1347. *https://doi.org/10.1292/jvms.19-0233*.

ABSTRACT

Influenza virus is known to affect wild felids. To explore the prevalence of influenza viruses in these animal species, 196 archival sera from 5 felid species including Panthera tigris (N=147),

Prionailurus viverrinus (N=35), Panthera leo (N=5), Pardofelis temminckii (N=8) and Neofelis nebulosa (N=1) collected between 2011 and 2015 in 10 provinces of Thailand were determined for the presence of antibody to avian and human influenza viruses. Blocking enzyme-linked immunosorbent (ELISA) assay and hemagglutination inhibition (HI) assay were employed as the screening tests, which the serum samples with HI antibody titers ³20 were further confirmed by cytopathic effect/hemagglutination based-microneutralization (CPE/HA-based microNT) test. Based on HI and microNT assays, the seropositive rates of low pathogenic avian influenza (LPAI) H5 virus, highly pathogenic avian influenza (HPAI) H5 virus and human H1 virus were 1.53% (3/196), 2.04% (4/196) and 6.63% (13/196), respectively. In addition, we also found antibody against both LPAI H5 virus and HPAI H5 virus in 2 out of 196 tested sera (1.02%). Evidences of influenza virus infection were found in captive P. tigris in Kanchanaburi, Nakhon Sawan and Ratchaburi provinces of Thailand. The findings of our study highlights the need of a continuous active surveillance program of influenza viruses in wild felid species.

Nilanjan Chatterjee

TRANSBOUNDARY

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATION

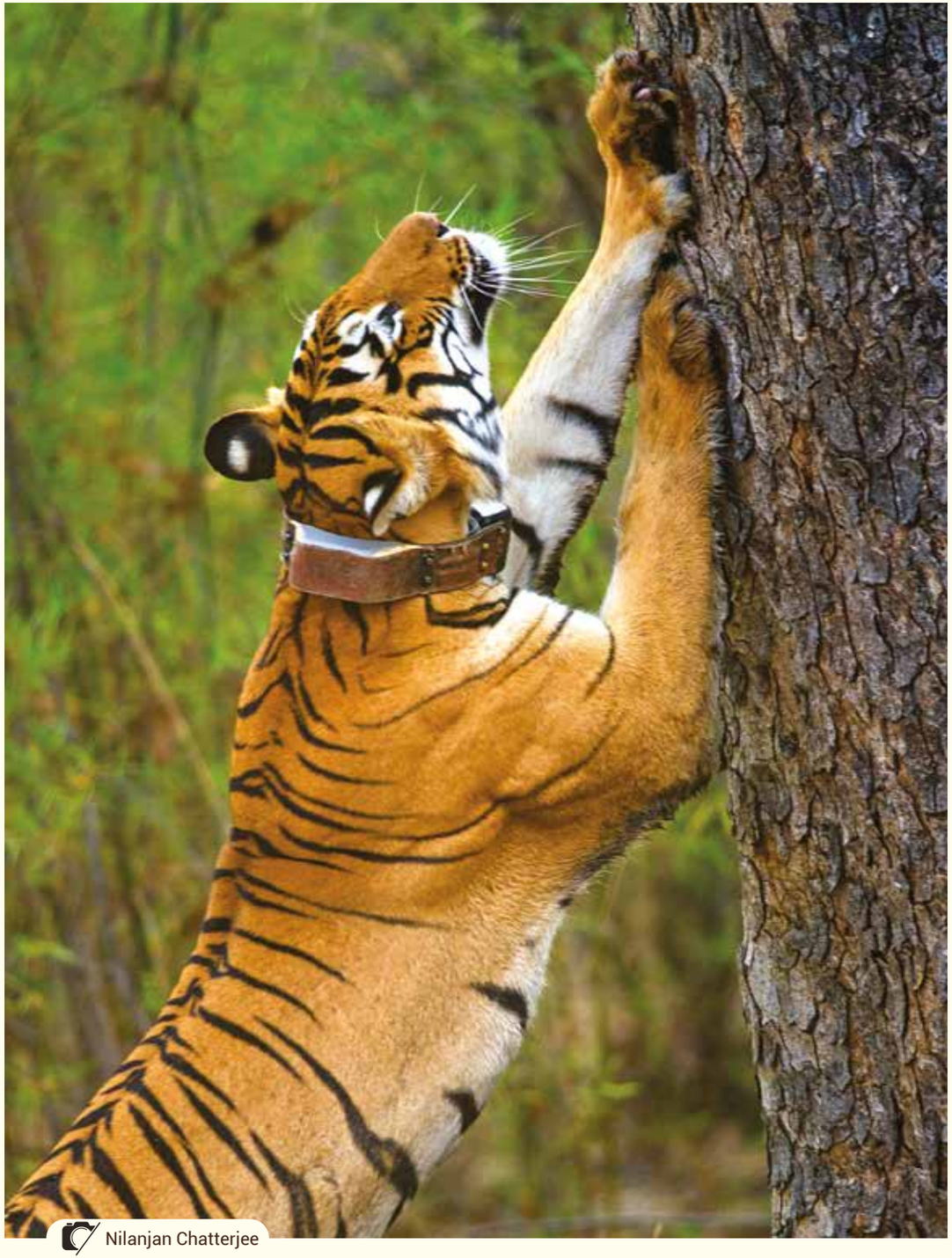
Lahkar, D., and Ahmed, M. F. (2019). Transboundary Tiger Conservation in Indo-Bhutan Barnadi-Jomotshangkha Forest Complex (Technical Report No. TRCD: 11/2019).

ABSTRACT

Over the last 100 years, Tiger (Panthera tigris) has lost their 93% population in Asia (Wolf and Ripple 2017) and population is continued to be decline despite of massive conservation initiatives throughout its range countries. Exploring potentiality of tiger conservation across landscape, connectivity between two source sites and measuring threats are the key for any management intervention. The Transboundary Manas Conservation Area (TraMCA) across the international boundary of India and Bhutan, is a significant tiger habitat that has potential to double its tiger population within a decade (Ahmed et al. 2016). The TraMCA with an area of over 6500 sq km spans from the river Sankosh, the western boundary of Manas Tiger Reserve, India to the Jomotsangkha Wildlife Sanctuary, Bhutan to the east. To the south it extends to the southern boundary of the Manas Tiger reserve (MTR) in India and to the north, the northern extend of the Royal Manas National Park (RMNP) in Bhutan. A combined record of the TraMCA indicate the local species composition includes more than 65 species of mammals, over 500 species of birds and more than 1000 species of plants (Ahmed et al. 2016). Key species include Tiger, Elephant, Pigmy Hog, Bengal Florican, Clouded Leopard, Common Leopard, Gaur, etc. Recognizing the importance of transboundary level approach in protecting the biodiversity in these highly diverse ecosystems across the international boundary between India and Bhutan, TraMCA was conceptualised in the years 2011 under the 'Living Himalayas Initiative'. The joint transboundary tiger monitoring study which started in 2011 is a paradigm of a successful transboundary conservation effort to safeguard tiger population across TraMCA. Studies carried out on tigers, co-predators their prey animals, between 2011-2018 reveals that a total cumulative number of minimum 70 individual tigers have been identified in the TraMCA (Manas and Royal Manas NP) (Unpublished data from TraMCA landscape).. While, transboundary tiger conservation focuses the Manas National Park and the Royal Manas National Park core, this study was designed to explore the status of tigers and habitats in a new underexplored area on the eastern part of the TraMCA, the Barnadi-Jomotsankha transboundary area that has strong potential to be another core tiger habitat in the landscape. This study would significantly assist the protected area managers and government of the two countries to strengthen tiger and habitat conservation in areas beyond the Manas National Park-Royal Manas National Park core of the TraMCA. This study was a part of the initiatives of Transboundary Biodiversity Management (TBM) approach includes management of two or more contiguous protected

areas across International political boundaries. It is also a global Tiger Conservation landscape (TCL # 37) (Northern forest Complex-Namdapha-Royal Manas) entity (Sanderson et al. 2006). There was little systematic effort to study on tigers, co-predators and prey animals in this forest complex of the TraMCA except the Manas National Park and RMNP. With the photo-capture of an adult male tiger in 2016, confirmed record of tiger presence was established in the sanctuary. However, this study was the first opportunity to bring these transboundary conservation sites to the attention of conservationist and policymakers as another transboundary tiger conservation core area. Considering potential of doubling the tiger population in the TraMCA landscape, this study has helped in setting baseline and would significantly contribute in conservation of tigers in the landscape.

Sandesh Kadur



Nilanjan Chatterjee

Shibu Nair

ASIA

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATIONS

Threats

Ash, E., Cushman, S. A., Macdonald, D. W., Redford, T., and Kaszta, Ż. (2020). How important are resistance, dispersal ability, population density and mortality in temporally dynamic simulations of population connectivity? A case study of tigers in Southeast Asia. Land, 9, 415. *https://doi.org/10.3390/land9110415*

ABSTRACT

Development of landscape connectivity and spatial population models is challenging, given the uncertainty of parameters and the sensitivity of models to factors and their interactions over time. Using spatially and temporally explicit simulations, we evaluate the sensitivity of population distribution, abundance and connectivity of tigers in Southeast Asia to variations of resistance surface, dispersal ability, population density and mortality. Utilizing a temporally dynamic cumulative resistant kernel approach, we tested (1) effects and interactions of parameters on predicted population size, distribution and connectivity, and (2) displacement and divergence in scenarios across timesteps. We evaluated the effect of varying levels of factors on simulated population, cumulative resistance kernel extent, and kernel sum across nine timesteps, producing 24,300 simulations. We demonstrate that predicted population, range shifts, and landscape connectivity are highly sensitive to parameter values with significant interactions and relative strength of effects varying by timestep. Dispersal ability, mortality risk and their interaction dominated predictions. Further, population density had intermediate effects, landscape resistance had relatively low impacts, and mitigation of linear barriers (highways) via lowered resistance had little relative effect. Results are relevant to regional, long-term tiger population management, providing insight into potential population growth and range expansion across a landscape of global conservation priority.

Carter, N. H., Killion, A. K., Easter, T., Brandt, J. S., and Ford, A. T. (2020). Road development in Asia: Assessing the range-wide risks to tigers. Science Advances, 6(18), eaaz9619.

ABSTRACT

Roads are proliferating worldwide at an unprecedented rate, with potentially severe impacts on wildlife. We calculated the extent and potential impacts of road networks across the 1,160,000-km^2, 13-country range of the globally endangered tiger (Panthera tigris)—a conservation umbrella species. We found that roads were pervasive, totaling 134,000 km across tiger conservation landscapes (TCLs), even in tiger priority sites and protected areas. Approximately 43% of the area where tiger breeding occurs and 57% of the area in TCLs fell within the road-effect zone. Consequently, current road networks may be decreasing tiger and prey abundances by more than 20%. Nearly 24,000 km of new roads will be built in TCLs by 2050, stimulated through major investment projects such as China's Belt and Road Initiative. Given that roads will be a pervasive challenge to tiger recovery in the future, we urge decision-makers to make sustainable road development a top priority.

Simlipal TR / Yashpal Rathore

BANGLADESH

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Aziz, M. A., Islam, M. A., and Groombridge, J. J. (2020). Spatial differences in prey preference by tigers across the Bangladesh Sundarbans reveal a need for customized strategies to protect prey populations. Endangered Species Research, 43, 65-73.
http://dx.doi.org/10.3354/esr01052

ABSTRACT

The Sundarbans is the only mangrove habitat in the world to support tigers Panthera tigris, whose persistence there is believed to be dependent on a very limited number of prey species. Conservation managers therefore need to understand how tigers utilise available prey species on a spatial scale in order to formulate a prey-based protection strategy for this global-priority tiger landscape. A total of 512 scat samples were collected during a survey of 1984 km^2 of forest across 4 sample blocks in the 6017 km^2 of the Bangladesh Sundarbans. Analysis of scat composition and prey remains reliably identified 5 major prey species, of which spotted deer Axis axis and wild pig Sus scrofa contributed a cumulative biomass of 89% to tiger diet. Tiger preference for prey species was highly skewed towards spotted deer and wild pig, but the relative contribution of these 2 species differed significantly across the 4 study areas, which spanned the Sundarbans, demonstrating important spatial patterns of tiger prey preference across the Sundarbans landscape. Given the comparatively limited number of prey species available to support the dwindling tiger population, different strategies are needed in different parts of the Sundarbans to support tiger populations and to protect spotted deer and wild pig populations from unabated poaching.

Shibu Nair

BHUTAN

CONSERVATION, MANAGEMENT AND POLICY RECOMMENDATION

Thinley, P., Rajaratnam, R., Morreale, S. J., and Lassoie, J. P. (2020). Assessing the adequacy of a protected area network in conserving a wide-ranging apex predator: The case for tiger (Panthera tigris) conservation in Bhutan. Conservation Science and Practice, 3, e318. *https://doi.org/10.1111/csp2.318*

ABSTRACT

Protected area networks (PAN) are essential for conserving wide-ranging apex predators but their adequacy in species protection has rarely been assessed. Here, we assess the adequacy of Bhutan's PAN in conserving and providing connectivity to the endangered tiger (Panthera tigris). We determine the current extent of tiger habitat, predict new suitable habitat, identify potential corridors, and empirically estimate the range of tiger numbers that Bhutan can spatially support. We use two spatial models with different approaches to ascertain current tiger distribution and predict new suitable tiger areas: (a) an expert model based on tiger ecology and (b) an observation model from observed tiger distribution. The expert model identified more suitable tiger areas (32,887 km^2) over the observation model (29,962 km^2), with the PAN encompassing 46% and 45% of predicted suitable areas, respectively. Vast suitable tiger habitat remains unprotected. Based on our estimates of total suitable habitats, Bhutan can spatially support 138–151 tigers compared to the current estimate of 103, thereby precluding a doubling in tiger numbers. To ensure adequate protection of tigers in Bhutan, we recommend readjusting and/or expanding existing PAN boundaries, including the designation of new corridors, protecting habitats, and conserving prey populations.

Thinley, P., Dendup, T., Rajaratnam, R., Vernes, K., Tempa, K., Chophel, T., and Norbu, L. (2020). Tiger reappearance in Bhutan's Bumdeling Wildlife Sanctuary: A case for maintaining effective corridors and metapopulations. Animal Conservation, 23, 629-631. *https://doi.org/10.1111/acv.12580*

ABSTRACT

The article discusses the reappearance of a male tiger in Bhutan's Bumdeling Wildlife Sanctuary after a likely absence of 12 years. The tiger's presence in the sanctuary highlights the importance of maintaining effective corridors and metapopulations for the survival of tigers in Bhutan.

CAMBODIA

CONSERVATION, MANAGEMENT AND POLICY RECOMMENDATION

Gray, T., Grainger, M., and Grosu, R. (2020). Conservation decision-making under uncertainty: Identifying when to reintroduce tiger Panthera tigris to Cambodia. Conservation Science and Practice, 2. *https://doi.org/10.1111/csp2.187*

ABSTRACT

Conservationists need to present biological monitoring data to decision makers in a way which clearly represents uncertainty. Providing results in terms of the probability of a hypothesis being true may have greater utility for decision-making than traditionally used frequentist statistical approaches. Here, we demonstrate such an approach with regard to assessing the suitability of the Cardamom Rainforest Landscape, Cambodia for Panthera tigris (tiger) reintroduction. We estimated the density of tiger prey in the core of the landscape using the Random Encounter Model from camera-trap data and used Monte Carlo simulation to prorogate uncertainty around our model parameter estimates. This suggests there is currently a low probability that the core area of the landscape supports sufficient prey for a population of 25 adult tigers and that significant prey recovery is thus required prior to any reintroduction into the landscape. The Random Encounter Model contains a number of assumptions and we stress our main purpose is to illustrate an approach to incorporating uncertainty into conservation decision-making rather than providing robust estimation of current tiger prey densities in the Cardamom Rainforest Landscape. Our approach has wide utility for conveying species monitoring information to conservation planners in a simple to understand fashion.

Tapan Seth

CHINA

CONSERVATION, MANAGEMENT AND POLICY RECOMMENDATION

Qi, J., Holyoak, M., Ning, Y., and Jiang, G. (2020). Ecological thresholds and large carnivore conservation: Implications for the Amur tiger and leopard in China. Global Ecology and Conservation, 21, e00837. *https://doi.org/10.1016/j.gecco.2019.e00837*.

ABSTRACT

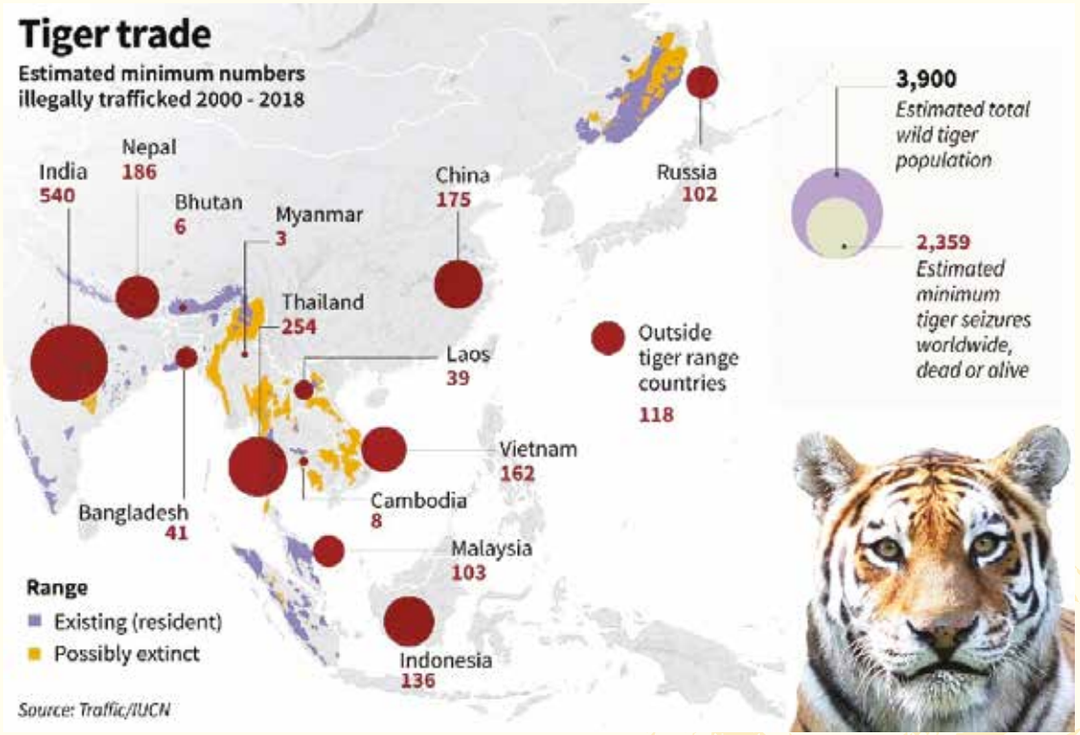
The ecological threshold concept describes how changes in one or more factors at thresholds can result in a large shift in the state of an ecosystem. This concept focuses attention on limiting factors that affect the tolerance of systems or organisms and changes in them. Accumulating empirical evidence for the existence of ecological thresholds has created favorable conditions for practical application to wildlife conservation. Applying the concept has the potential to enhance conservation of two large carnivores, Amur tiger and leopard, and the knowledge gained could guide the construction of a proposed national park. In this review, ecological thresholds that result from considering a paradigm of bottom-up control were evaluated for their potential to contribute to the conservation of Amur tiger and leopard. Our review highlights that large carnivores, as top predators, are potentially affected by ecological thresholds arising from changes in climate (or weather), habitat, vegetation, prey, competitors, and anthropogenic disturbances. What's more, interactions between factors and context dependence need to be considered in threshold research and conservation practice, because they may amplify the response of ecosystems or organisms to changes in specific drivers. Application of the threshold concept leads to a more thorough evaluation of conservation needs, and could be used to guide future Amur tiger and leopard research and conservation in China. Such application may inform the conservation of other large carnivores worldwide.

Illegal Trade

Song, Z., Wang, Q., Miao, Z., et al. (2020). The dissemination of relevant information on wildlife utilization and its connection with the illegal trade in wildlife. Journal of Forestry Research, 33, 357–367. *https://doi.org/10.1007/s11676-021-01306-y*.

ABSTRACT

We analyzed the generation and dissemination of relevant information on wildlife utilization based on the African bush elephant (Loxodonta africana Blumenbach.), the tiger (Panthera tigris L.) and the totoaba, a species of marine fish, (Totoaba macdonaldi Gilbert) as examples, whose populations are more threatened by the illegal wildlife trade. We compared the illegal trade in wildlife with related information in order to find possible associations, searched for relevant information on major international websites to summarize similarities in information production and dissemination, and used a “Zhiwei” dissemination analysis platform to analyze the dissemination of information circulated at Microblog. The results show that the most influential information related to the trade in wildlife is mainly generated from news media websites and new selfmedia platforms, usually from non-governmental organizations concerned with wildlife protection. The main factors that affect the depth and breadth of disseminating relevant information on wildlife utilization include the participation of relatively influential opinion leaders, the verification ratio of forwarding users, the number of followers, and affective identification. Misleading information can stimulate and promote poaching and smuggling, regardless of their real market demand or their products. Therefore, all links in the course of information dissemination should be carefully examined in order to purify the information environment and reduce adverse effects of misleading information on wildlife protection.



GENETICS

Zhao, X., Qiu, Q., Li, C., Fu, D., Hu, X., Gao, S., Zhu, Y., Mu, H., Wang, R., Yang, H., and Li, B. (2020). Genome-based development of 15 microsatellite markers in fluorescent multiplexes for parentage testing in captive tigers. PeerJ, 8, e8939. *https://doi.org/10.7717/peerj.8939*

ABSTRACT

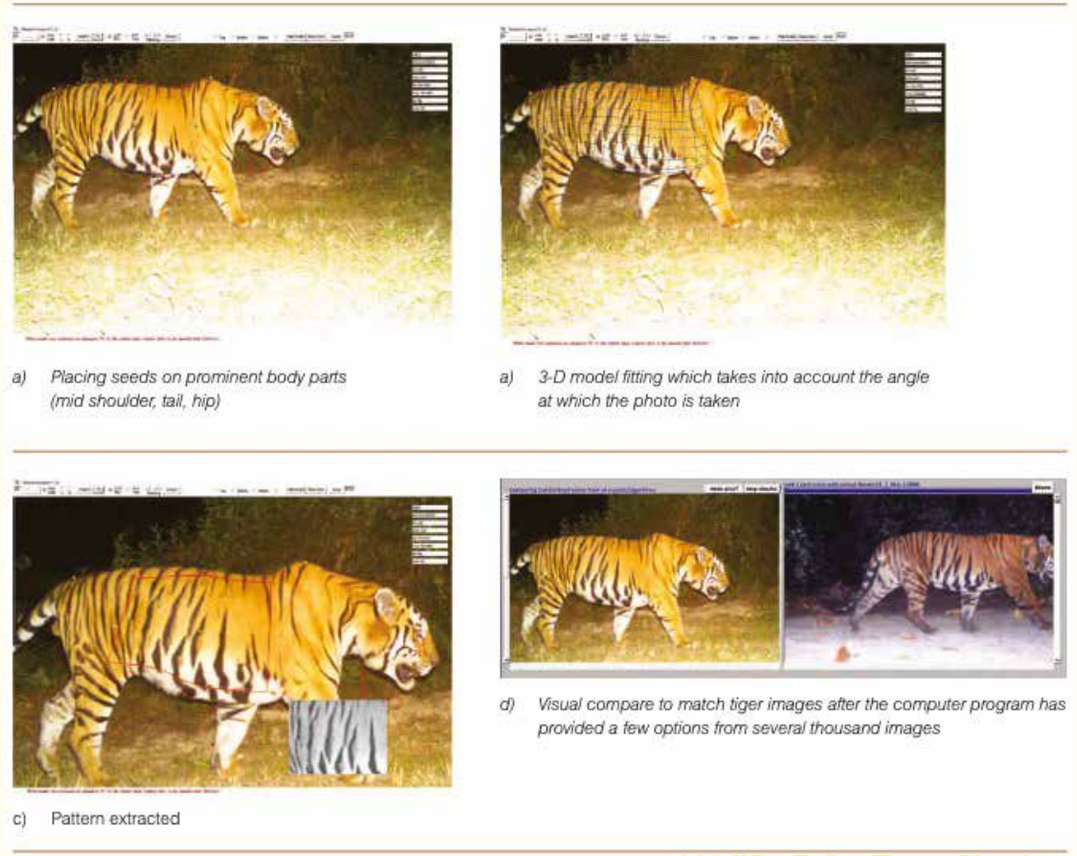
As one of the most endangered species, tiger (Panthera tigris) inbreeding has become an urgent issue to address. Using a microsatellite (short tandem repeat, STR) identification system, paternity testing may be helpful to avoid inbreeding in captive breeding programs. In this study, we developed a genome-based identification system named tiger pedigree identification multiplex system (TPI-plex). By analyzing the entire tiger genome, 139,967 STR loci were identified and 12.76% of these displayed three to six alleles among three re-sequenced individual tiger genomes. A total of 204 candidate STRs were identified and screened with a reference population containing 31 unrelated captive tigers. Of these, 15 loci were chosen for inclusion in the multiplex panel. The mean allele number and mean expected heterozygosity (He) were 7.3333 and 0.7789, respectively. The cumulative probability of exclusion (CPE) and total probability of discrimination power (TDP) reached 0.999999472 and 0.999999999999995, respectively. The results showed that the TPI-plex system can be applied in routine pedigree identification for captive tigers. We also added a sex identification marker named TAMEL into the TPI-plex for sex determination.

Wang, T., Feng, L., Yang, H., Bao, L., Wang, H., and Ge, J. (2020). An introduction to Long-term Tiger-Leopard Observation Network based on camera traps in Northeast China. Biodiversity Science, 28(9), 1059-1066.

ABSTRACT

The Long-term Tiger-Leopard Observation Network (TLON) is a camera trap based program that was established in 2006 by Beijing Normal University. TLON covers an area of more than 15,000 km^2 and is located in the temperate broadleaf and mixed forest in Northeast China. This area covers the Laoye Mountains, Zhangguangcai Mountains, and Wanda Mountains. The goals of TLON are to monitor the status of the Amur tiger (Panthera tigris altaica), Amur leopard (Panthera pardus orientalis), ungulate prey, and other sympatric mammal species. Additionally, a goal for TLON is to study animal's response to different environmental factors and human activity. As of June 2019, TLON has more than 785,000 video recordings that include recordings for 28 wild mammal species and 32 wild birds species that span 1,736,000 days of camera trapping. TLON has helped advance several fields of scientific research which include: surveying of wildlife diversity, studying population status of animals, understanding the distribution and threats for tigers and leopards, interactions between sympatric carnivore species, and mammal habitat use. TLON has also helped with monitoring, evaluation, and the management of biodiversity in the Northeast Tiger and Leopard National Park.

SUSTAINABLE SOLUTIONS AND TECHNOLOGY



a) Placing seeds on prominent body parts (mid shoulder, tail, hip)

a) 3-D model fitting which takes into account the angle at which the photo is taken

c) Pattern extracted

d) Visual compare to match tiger images after the computer program has provided a few options from several thousand images

Shi, C., Liu, D., Cui, Y., Xie, J., Roberts, N. J., and Jiang, G. (2020). Amur tiger stripes: Individual identification based on deep convolutional neural network. Integrative Zoology, 15(6), 461–470. *https://doi.org/10.1111/1749-4877.12453*.

ABSTRACT

The automatic individual identification of Amur tigers (Panthera tigris altaica) is important for population monitoring and making effective conservation strategies. Most existing research

primarily relies on manual identification, which does not scale well to large datasets. In this paper, the deep convolution neural networks (CNNs) algorithm is constructed to implement the automatic individual identification for large numbers of Amur tiger images. The experimental data were obtained from 40 Amur tigers in Tieling Guaipo Tiger Park, China. The number of images collected from each tiger was approximately 200, and a total of 8,277 images were obtained. The experiments were carried out on both the left and right side of body. Our results suggested that the recognition accuracy rate of left and right sides are 90.48% and 93.5%, respectively. The accuracy of our network has achieved the similar level compared to other state of the art networks like LeNet, ResNet34 and ZF_Net. The running time is much shorter than that of other networks. Consequently, this study can provide a new approach on automatic individual identification technology in the case of the Amur tiger.

Cheng, X., Zhu, J., Zhang, N., Wang, Q., and Zhao, Q. (2020). Detection Features as Attention (Defat): A Keypoint-Free Approach to Amur Tiger Re-Identification. In 2020 IEEE International Conference on Image Processing (ICIP) (pp. 2231-2235). Abu Dhabi, United Arab Emirates. *https://doi.org/10.1109/ICIP40778.2020.9190667*

ABSTRACT

Automatically identifying animals in camera-trap images has attracted increasing attention due to its valuable potential in wildlife conservation. A typical pipeline of existing methods includes separated animal detection and re-identification modules, and state-of-the-art re-identification methods either use annotated keypoints of animals to extract robust features, or employ extra branches to learn multiple features. In this paper, in contrast, we propose a keypoint-free approach to Amur tiger re-identification by exploiting the feature maps extracted by the detection module to help the re-identification module learn more effective features. We devise a detection-features-as-attention (DeFAt) module, which generates an additive mask for the input image based on the detection feature maps. We experimentally show that using the masked image the re-identification module lays more attention on the tiger region in the image, while the distraction by the messy background is removed to some extent. Our evaluation results prove that the proposed DeFAt module can effectively improve the Amur tiger re-identification accuracy when key-point annotations are not available.

ZOOLOGY AND ANIMAL WELFARE

Jiao, C., Zhang, H., Liu, W., Jin, H., Liu, D., Zhao, J., Feng, N., Zhang, C., and Shi, J. (2020). Construction and immunogenicity of virus-like particles of feline parvovirus from the tiger. Viruses, 12(3), 315. *https://doi.org/10.3390/v12030315*

ABSTRACT

Feline panleukopenia, caused by feline parvovirus (FPV), is a highly infectious disease characterized by leucopenia and hemorrhagic gastroenteritis that severely affects the health of large wild Felidae. In this study, tiger FPV virus-like particles (VLPs) were developed using the baculovirus expression system. The VP2 gene from an infected Siberian tiger (Panthera tigris altaica) was used as the target gene. The key amino acids of this gene were the same as those of FPV, whereas the 101st amino acid was the same as that of canine parvovirus. Indirect immunofluorescence assay (IFA) results demonstrated that the VP2 protein was successfully expressed. SDS-PAGE and Western blotting (WB) results showed that the target protein band was present at approximately 65 kDa. Electron micrograph analyses indicated that the tiger FPV VLPs were successfully assembled and were morphologically similar to natural parvovirus particles. The hemagglutination (HA) titer of the tiger FPV VLPs was as high as 1:218. The necropsy and tissue sections at the cat injection site suggested that the tiger FPV VLPs vaccine was safe. Antibody production was induced in cats after subcutaneous immunization, with a >1:210 hemagglutination inhibition (HI) titer that persisted for at least 12 months. These results demonstrate that tiger FPV VLPs might provide a vaccine to prevent FPV-associated disease in the tiger.

Liu, E., Ma, L., You, D., et al. (2020). Haematological and Biochemical Parameters of Captive Siberian Tigers (Panthera tigris altaica) from the Heilongjiang Province, China. Veterinary Medicine and Science, 7, 1015–1022. *https://doi.org/10.1002/vms3.395*

ABSTRACT

Haematological and biochemical parameters play important roles in safeguarding animal health and preventing disease, but the blood reference values of many wild animals are still unknown. Recently, few descriptions of the blood parameters of Siberian tigers (Panthera tigris altaica) have been reported because these tigerscomprise an endangered species; however, it is extremely difficult to obtain blood samples necessary for these analyses. This study presents 14 haematological and 16 biochemical parameters of 133 Siberian tigers, of which 112 and 21 were from Heilongjiang Siberian Tiger Park (HB) and Hailin Siberian Tiger Park (HD), China, respectively. Our study is the first to determine the following parameters in Siberian

tigers: red blood cell volume distribution width, platelet count, mean platelet volume, amylase (AMY), sodium/potassium, globulin and albumin/globulin levels. As the data for total bilirubin and AMY were not statistically significant, no statistical analysiswas conducted for these parameters. Few parameters were significantly different according to sex and region ($p < 0.05$). The concentration of alkaline phosphatase decreased with age, whereas the creatinine (CREA) increased with age. The CREA concentration of tigers raised in HB was much lower than that of tigers raised in HD. The data obtained in this study provide a reference for monitoring the health of wild and captive Siberian tigers and will add important information to the standards for haematological and biochemical parameters of wild felines.

Peng, Z., Ning, Y., Liu, D., Sun, Y., Wang, L. X., Zhai, Q., Hou, Z., Chai, H., and Jiang, G. (2020). Ascarid infection in wild Amur tigers (Panthera tigris altaica) in China. BMC Veterinary Research, 16(1), 1-7. *https://doi.org/10.1186/s12917-020-02296-5*

ABSTRACT

Background: Wild Amur tigers are a sparsely populated species, and the conservation of this species is of great concern worldwide, but as an important health risk factor, parasite infection in them is not fully understanding. Results: In this study, sixty-two faecal samples were collected to investigate the frequency and infection intensity of Toxocara cati and Toxascaris leonina in wild Amur tigers. The T. cati and T. leonina eggs were preliminary identified by microscopy, and confirmed by molecular techniques. Infection intensity was determined by the modified McMaster technique. Phylogenetic trees demonstrated that T. cati of wild Amur tiger had a closer relationship with which of other wild felines than that of domestic cats. T. leonina of Amur tiger and other felines clustered into one clade, showing a closer relationship than canines. The average frequency of T. cati was 77.42% (48/62), and the frequency in 2016 (100%) were higher than those in 2013 (P = 0.051, < 0.1; 66.6%) and 2014 (P = 0.079, < 0.1; 72.2%). The infection intensity of T. cati ranged from 316.6 n/g to 1084.1 n/g. For T. leonina, only three samples presented eggs when the saturated sodium chloride floating method was performed, indicating that the frequency is 4.83% (3/62). Unfortunately, the egg number in faecal smears is lower than the detective limitation, so the infection intensity of T. leonina is missed. Conclusions: This study demonstrated that ascarids are broadly prevalent, and T. cati is a dominant parasite species in the wild Amur tiger population.

Wang, Y., Yao, J., Dai, J., Ma, L., Liu, D., Xu, H., Cui, Q., Ma, J., and Zhang, H. (2020). Per- and polyfluoroalkyl substances (PFASs) in blood of captive Siberian tigers in China: Occurrence and association with biochemical parameters. Environmental Pollution, 265(B), 114805. *https://doi.org/10.1016/j.envpol.2020.114805*

ABSTRACT

Per- and polyfluoroalkyl substances (PFASs) have been ubiquitously detected in the environment and marine animals. However, little is known about these substances and their associations with health parameters in wild terrestrial mammals. In this study, we determined PFAS levels and distribution in the blood of captive Siberian tigers in Harbin, China, and evaluated potential exposure pathways by daily intake. In addition, for the first time, we explored the associations between serum PFAS concentrations and clinical parameters. Results showed that perfluorooctanoate (PFOA) was the dominant PFAS compound in blood (accounting for 64%), followed by perfluorooctanesulfonate (PFOS). In addition, 6:2 chlorinated polyfluorinated ether sulfonate (6:2 Cl-PFESA) concentrations were also detected in blood and dietary food. Furthermore, significant positive age relationships were observed for levels of perfluoroheptanoate (PFHpA), PFOA, PFOS, and 6:2 Cl-PFESA in the blood of female tigers. Results showed that PFOA and PFOS in dietary food accounted for over 70% of total daily intake of PFASs, indicating that meat consumption is a predominant exposure pathway in tigers. We also found positive associations between higher exposure to PFASs (including PFOA, PFOS, and 6:2 Cl-PFESA) and elevated serum levels of alanine transaminase (ALT), a marker of liver damage. Thus, comprehensive health assessments of PFAS burdens in wildlife are needed.

Yuan, Y.-H., Pei, E.-L., and Liu, Q.-X. (2020). Reproductive parameters of female South China Tigers in captivity. European Journal of Wildlife Research, 66(3), 1-6. *http://dx.doi.org/10.1007/s10344-020-01375-0*

ABSTRACT

We monitored the reproductive parameters of South China Tigers (SCT) in captivity from 1983 to 2018. Tigers gave birth in all but 3 months of the year, with a peak in May, June, and July (goodness of fit test, $\chi 2 = 49.928$, $p = 0.000$, $n = 270$ litters from 65 mothers). The minimum age at 1st reproduction was 4.96 ± 2.43 (standard deviation, SD) years. The mean interval between litters was 410.2 ± 290.2 (SD) days ($n = 38$ pairs with consecutive reproduction). Mean litter size was 2.1 ± 0.9 (SD) ($n = 270$ litters from 65 tigers). The average survival rate of newborn cubs was 55.7% (SD = 17.7). There was significant maternal age variation among the litters studied. Reproduction mainly occurs in females in their prime (3–14 years old), with little in young and old females (one-way analysis of variance, ANOVA, $F = 8.314$, $p = 0.005$). Reproductive parameters of SCTs could be the basis of analysis on the population dynamics and management, and genetic considerations are necessary to plan future breeding programs and to assist in the selection of individuals for reintroduction to the wild.

GLOBAL

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Anatomy

Dunn, R. H., Beresheim, A., Gubatina, A., Bitterman, K., Butaric, L., Bejes, K., Kennedy, S., Markham, S., Miller, D., Mrvoljak, M., Roge-Jones, L., Stumpner, J., Walter, C., and Meachen, J. A. (2020). Muscular anatomy of the forelimb of tiger (Panthera tigris). Journal of Anatomy, 241(1), 119–144. *https://doi.org/10.1111/joa.13636*.

ABSTRACT

Dissection reports of large cats (family Felidae) have been published since the late 19th century. These reports generally describe the findings in words, show drawings of the dissection, and usually include some masses of muscles, but often neglect to provide muscle maps showing the precise location of bony origins and insertions. Although these early reports can be highly useful, the absence of visual depictions of muscle attachment sites makes it difficult to compare muscle origins and insertions in living taxa and especially to reconstruct muscle attachments in fossil taxa. Recently, more muscle maps have been published in the primary literature, but those for large cats are still limited. Here, we describe the muscular anatomy of the forelimb of the tiger (Panthera tigris), and compare muscle origins, insertions, and relative muscle masses to other felids to identify differences that may reflect functional adaptations. Our results reiterate the conservative nature of felid anatomy across body sizes and behavioral categories. We find that pantherines have relatively smaller shoulder muscle masses, and relatively larger muscles of the caudal brachium, pronators, and su-pinators than felines. The muscular anatomy of the tiger shows several modifications that may reflect an adaptation to terrestrial locomotion and a preference for large prey. These include in general a relatively large m. supraspinatus (shoulder flexion), an expanded origin for m. triceps brachii caput longum, and relatively large m. triceps brachii caput laterale (elbow extension), as well as relatively large mm. brachioradialis, abductor digiti I longus, and abductor digiti V. Muscle groups that are well developed in scansorial taxa are not well developed in the tiger, including muscles of the cranial compartment of the brachium and antebrachium, and m. anconeus. Overall, the mus-culature of the tiger strongly resembles that of the lion (Panthera leo), another large-bodied terrestrial large-prey specialist.

Ecology

Anile, S., and Devillard, S. (2020). Spatial variance-mass allometry of population density in felids from camera-trapping studies worldwide. Scientific Reports, 10, 14814. *https://doi.org/10.1038/s41598-020-71725-0*

ABSTRACT

Power laws are cornerstone relationships in ecology and evolutionary biology. The density-mass allometry (DMA), which predicts an allometric scaling of population abundance, and Taylor's law (TL), which predicts a decrease in the population abundance variation along with a decrease in population density, have enhanced our knowledge of inter- and intra-specific variation in population abundance. When combined, these two power laws led to the variance-mass allometry (VMA), which states that larger species have lower spatial variation in population density than smaller species. The VMA has been predicted through theoretical models, however few studies have investigated if this law is also supported by empirical data. Here, to formally test the VMA, we have used the population density estimates obtained through worldwide camera trapping studies for an emblematic and ecologically important carnivorous taxa, the Felidae family. Our results showed that the VMA law hold in felids, as well as the TL and the DMA laws; bigger cat species showed less variation for the population density than smaller species. These results have important implications for the conservation of wildlife population and confirm the validity of important ecological concepts, like the allometric scaling of population growth rate and the slow-fast continuum of life history strategies.

Tidière, M., Müller, P., Sliwa, A., Siberchicot, A., and Douay, G. (2020). Sex-specific actuarial and reproductive senescence in zoo-housed tiger (Panthera tigris): The importance of sub-species for conservation. Zoo Biology, 40(4), 320–329. *https://doi.org/10.1002/zoo.21610*

ABSTRACT

A fifth of all known species are currently classified as threatened in the wild: the rate of biodiversity loss is rapid, continuous, and mostly due to anthropogenic activities. To slow down this decline, the accurate estimation of demographic parameters for threatened species is critical. With this aim, zoo institutions play an important role, giving access to data on zoo-housed animals, which aids researchers working on species life-history traits and intrinsic factors influencing the fitness of both sexes, such as age. While tigers (Panthera tigris) are particularly threatened in their natural environment, few of their demographic parameters have been determined because of their solitary and elusive nature as well as low population density. Using individual-based information for more than 9200 tigers (from 1938 to 2018) recorded in

the International Tiger Studbook 2018, we aimed to determine sub-species and sex-specific variability of survival and reproductive parameters with age. No significant sex-difference in actuarial senescence (i.e., decline of survival probabilities with age) was observed but males tended to have a higher juvenile mortality and a faster senescence than females. Reproductive senescence (i.e., decline of reproductive parameters with age) was more pronounced in females than males. Moreover, we observed sub-species-specific variation in mortality and reproductive patterns, pointing out the necessity to consider them independently for conservation goals. Our findings can provide meaningful improvements to the husbandry of zoo-housed tigers, emphasizing the importance of adult breeding females of 7-9 years-old to control zoo-housed population size, but also providing accurate demographic estimates, crucial to set up effective conservation plans.

Behaviour

Gomes, D., McSweeney, L., and Santos, M. (2020). Effects of environmental enrichment techniques on stereotypical behaviors of captive Sumatran tigers: A preliminary case study. Journal of Animal Behavior and Biometeorology, 7, 144-148.

ABSTRACT

Wild animals are maintained in Zoological facilities for purposes of education, conservation, research, and recreation. Several studies have proven that the surroundings of an animal's artificial habitat, as well as environmental enrichment techniques, are factors that influence behaviour and have an impact on animals' welfare. In the present work carried out at Fota Wildlife Park, Cork, Republic of Ireland, we observed and collected information concerning three Sumatran Tigers (Panthera tigris sumatrae). The research achievements, registered on an ethogram, seem to demonstrate a link between the enclosure features and the environmental enrichment techniques applied with the stereotypical behaviours directly observed. In fact, the obtained results show that the characteristics of the enclosures were a determining factor on the tiger's behaviour. The obtained results also depict and highlight the extreme relevance of individual ethos when choosing the environmental enrichment techniques applied in order to reduce stereotypical behaviours observed in the captive tigers.

CONSERVATION, MANGEMENT AND POLICY RECOMMENDATION

Ana Janžić. (2020). The Challenges of Tiger Conservation in Natural Habitats. Dissertation. University of Zagreb, Faculty of Science, Zagreb, Crotia.

SUMMARY

Panthera tigris is the largest species within the Panthera genus and the entire cat family (Felidae) (web source 1). With a body length ranging from 2.2 to 3 meters, it is the largest predator in the Asian region (Mazák, 1981). It holds significant cultural importance in many Asian countries such as China, India, Japan, South Korea, and Malaysia. In Indian mythology, the tiger is considered a deity, while in China, it symbolizes power and strength (web source 2). Its importance in various cultures is one of the reasons for its endangerment, yet at the same time, it represents the last hope for the conservation of the species in its natural habitat.

ZOOLOGY AND ANIMAL WELFARE

Bartlett, S. L., Diel, D. G., Wang, L., Zec, S., Laverack, M., Martins, M., Caserta, L. C., Killian, M. L., Terio, K., Olmstead, C., Delaney, M. A., Stokol, T., Ivančić, M., Jenkins-Moore, M., Ingerman, K., Teegan, T., McCann, C., Thomas, P., McAloose, D., Sykes, J. M., … Calle, P. P. (2020). Sars-Cov-2 Infection And Longitudinal Fecal Screening In Malayan Tigers (Panthera Tigris Jacksoni), Amur Tigers (Panthera Tigris Altaica), And African Lions (Panthera Leo Krugeri) At The Bronx Zoo, New York, Usa. Journal of zoo and wildlife medicine, 51(4), 733–744. *https://doi.org/10.1638/2020-0171*.

ABSTRACT

Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) emerged as the cause of a global pandemic in 2019-2020. In March 2020, New York City became the epicenter in the United States for the pandemic. On 27 March 2020, a Malayan tiger (Panthera tigris jacksoni) at the Bronx Zoo in New York City developed a cough and wheezing with subsequent inappetence. Over the next week, an additional Malayan tiger and two Amur tigers (Panthera tigris altaica) in the same building and three lions (Panthera leo krugeri) in a separate building also became ill. The index case was anesthetized for diagnostic workup. Physical examination and bloodwork results were unremarkable. Thoracic radiography and ultrasonography revealed a bronchial pattern with peribronchial cuffing and mild lung consolidation with alveolar-interstitial syndrome, respectively. SARS-CoV-2 RNA was identified by real-time, reverse transcriptase PCR (rRT-PCR) on oropharyngeal and nasal swabs and tracheal wash fluid. Cytologic examination of tracheal wash fluid revealed necrosis, and viral RNA was detected in necrotic cells by in

situ hybridization, confirming virus-associated tissue damage. SARS-CoV-2 was isolated from the tracheal wash fluid of the index case, as well as the feces from one Amur tiger and one lion. Fecal viral RNA shedding was confirmed in all seven clinical cases and an asymptomatic Amur tiger. Respiratory signs abated within 1-5 days for most animals, although they persisted intermittently for 16 days in the index case. Fecal RNA shedding persisted for as long as 35 days beyond cessation of respiratory signs. This case series describes the clinical presentation, diagnostic evaluation, and management of tigers and lions infected with SARS-CoV-2 and describes the duration of viral RNA fecal shedding in these cases. This report documents the first known natural transmission of SARS-CoV-2 from humans to nondomestic felids.

Cabot, M. L., Ramsay, E. C., Chaffins, D., and Sula, M. M. (2020). Histologic Evidence of Spontaneous Ovulation in Tigers (Panthera Tigris). Journal of zoo and wildlife medicine: official publication of the American Association of Zoo Veterinarians, 51(3), 652–656. *https://doi.org/10.1638/2019-0216*.

ABSTRACT

Spontaneous ovulation has been identified in several wild felid species and domestic cats previously thought to undergo only induced ovulation. Two studies have assessed ovulation patterns in tigers (Panthera tigris) and have not found evidence of spontaneous ovulation in this species. However, uterine pathology typically associated with prolonged progesterone exposure has been identified in unbred tigers, suggesting spontaneous ovulation occurs. Ovaries from 47 tigers were reviewed with histologic examination. The presence or lack of active corpora lutea was documented and compared with social housing conditions for each animal. Social housing categories were as follows: female housed alone, female housed with other females, and female housed with at least one male. Active corpora lutea were identified in 66% (10/15) of females housed alone, 85% (6/7) of females housed with other females, and 58% of females housed with a male. A chi-squared test found the presence of active corpora lutea was independent of social housing condition. These results offer strong evidence of spontaneous ovulation in tigers. This finding suggests that a luteal control protocol with an early follicular inhibition agent may improve assisted reproduction efforts and supports spaying nonreproductive or postreproductive female tigers to reduce the rate of uterine infections.

Cavalera, M. A., Iatta, R., Laricchiuta, P., Passantino, G., Abramo, F., Mendoza-Roldan, J. A., Otranto, D., and Zatelli, A. (2020). Clinical, haematological and biochemical findings in tigers infected by Leishmania infantum. BMC veterinary research, 16(1), 214. *https://doi.org/10.1186/s12917-020-02419-y*.

ABSTRACT

Background: A large number of animal species are susceptible to Leishmania infantum (Kinetoplastida, Trypanosomatidae) in endemic areas, including domestic and wild felids such as tigers (Panthera tigris). Knowledge on the infection of this endangered species is still at its infancy, and therefore this study aims to identify clinical presentation and clinicopathological findings of tigers naturally infected by L. infantum.

Results: Tigers either L. infantum-positive (group A) or -negative (group B) were apparently healthy or presented visceral leishmaniasis unrelated conditions, except for one animal in which a large non-healing cutaneous lesion was observed. However, histological exam and immunohistochemistry carried out on the lesion excluded the presence of L. infantum amastigotes. Biochemical analysis showed that the average concentration of total proteins, globulins and haptoglobin were significantly higher ($p < 0.01$, $p = 0.01$ and $p = 0.02$, respectively), while the albumin/globulin ratio significantly lower ($p = 0.05$) in group A compared with group B. The biochemical alterations were partially confirmed by the serum protein electrophoresis results revealing a significant increase in the total protein value ($p = 0.01$) and hypergammaglobulinemia ($p = 0.03$) but an unmodified albumin/globulin ratio in group A.

Conclusions: In this study tigers infected by L. infantum have shown to be mainly asymptomatic. The absence of clinical signs may lead veterinarians to overlook leishmaniasis in animals kept in captivity. Therefore, diagnostic and screening tests as serology should be part of routinely surveillance programs to be performed on tigers in zoological gardens located in endemic areas. Though only few protein-related laboratory abnormalities were recorded in infected animals, they could provide diagnostic clues for a first suspicion of L. infantum infection in tigers. Indeed, considering the high risk of zoonotic transmission in heavily frequented environment as zoos, a prompt diagnosis of L. infantum infection is of pivotal importance.

Cerreta, A. J., LoBato, D. N., Ramsay, E. C., and Cushing, A. C. (2020). Histoplasmosis In Nondomestic Felids: A Review of Six Cases. Journal of zoo and wildlife medicine: official publication of the American Association of Zoo Veterinarians, 51(3), 720–724. *https://doi.org/10.1638/2019-0211*.

ABSTRACT

One adult leopard (Panthera pardus) and five adult tigers (Panthera tigris) presented with a range of nonspecific clinical signs, including lethargy (6/6), mobility deficits (4/6), and hyporexia (3/6). Hematology and biochemistry revealed a hyperproteinemia characterized by hyperglobulinemia (4/6), hepatocellular enzyme activity increases (3/6), azotemia (3/6), leukocytosis (2/6), hyperbilirubinemia (2/6), or a combination of conditions. Further diagnostics and management varied with the presenting signs and clinicopathological findings, including supportive care, diagnostic imaging, and blastomyces urine antigen analyses. Two animals died, and four were euthanatized. Postmortem findings included granulomatous pneumonia (6/6), fibrinous pleural effusion (3/ 6), pericardial effusion (2/6), and diffuse icterus (1/6). Histopathology revealed round to oval structures with a thin clear wall and purple inclusions within cells of the mononuclear phagocyte system, consistent with Histoplasma capsulatum, in each animal. Disseminated histoplasmosis was found in five cases, with organisms present in the lung (5/5), liver (3/5), lymph nodes (3/5), spleen (2/5), bone marrow (2/5), thyroid (1/5), tongue (1/ 5), kidney (1/5), or a combination of organs. One tiger was found to have pulmonary histoplasmosis without evidence of disseminated infection. On the basis of clinical and pathological findings, histoplasmosis was diagnosed. This case series illustrates the difficulties in antemortem diagnosis of histoplasmosis on the basis of complete blood count, serum biochemistry profile, and antigen testing and underscores that histoplasmosis should be considered a differential diagnosis in any felid presenting with nonspecific clinical signs in endemic areas.

Clayton, M., and Shrock, T. (2020). Making a Tiger's Day: Free-Operant Assessment and Environmental Enrichment to Improve the Daily Lives of Captive Bengal Tigers (Panthera tigris tigris). Behavior analysis in practice, 13(4), 883–893. *https://doi.org/10.1007/s40617-020-00478-z*.

ABSTRACT

There are more captive tigers in the United States than there are wild tigers in the entire world. Many animals under human care engage in problem behaviors such as excessive grooming and aggression, although the origin of these behaviors is typically unknown. Environmental enrichment may mitigate these issues in captive animals of all kinds. In order to individualize enrichment experiences, the current study used a free-operant assessment procedure to establish a menu of most preferred play items and scents among 7 Bengal tigers (Panthera tigris tigris) housed at a sanctuary in southwest Missouri. Each tiger was tested 3 times with scents (cinnamon and Calvin Klein Obsession perfume) and play items (boxes, balls, leaves, and pumpkins). The importance of rigorous assessment of presumed reinforcers among captive wild animals, as well as the difficulty of effectively assessing tigers while ensuring the safety of both the participants and researchers, is discussed.

Di Cesare, F., Cagnardi, P., Villa, R., Rabbogliatti, V., Lucatello, L., Capolongo, F., Gioeni, D., Capasso, M., Magnone, W., and Ravasio, G. (2020). Dexmedetomidine and ketamine simultaneous administration in tigers (Panthera tigris): pharmacokinetics and clinical effects. Veterinary record open, 7(1), e000412. *https://doi.org/10.1136/vetreco-2020-000412*.

ABSTRACT

Background: The study determines the pharmacokinetic profiles of dexmedetomidine (DEX), ketamine (KET) and its active metabolite, norketamine (NORKET), after simultaneous administration. Moreover, the study evaluates the sedative effects of this protocol, its influence on the main physiological variables and the occurrence of adverse effects.

Methods: Eighteen captive tigers were initially administered with a mixture of DEX (10 µg/kg) and KET (2 mg/kg) by remote intramuscular injection. In case of individual and specific needs, the protocol was modified and tigers could receive general anaesthesia, propofol or additional doses of DEX and KET.

Results: Based on the immobilisation protocol, nine animals were assigned to the standard protocol group and the other nine to the non-standard protocol group. Higher area under the first moment curve (AUMC0-last) and longer mean residence time (MRT0-last) ($P<0.05$) were observed in the non-standard protocol group for DEX, KET and NORKET, and higher area under the concentration-time curve from administration to the last measurable concentration (AUC0-last) only for KET. The KET metabolisation rate was similar ($P=0.296$) between groups. No differences between groups were detected in terms of stages of sedation and recoveries. All physiological variables remained within normality ranges during the whole observation period. During the hospitalisation period, no severe adverse reactions and signs of resedation were observed.

Conclusion: The simultaneous administration of 10 µg/kg of DEX and 2 mg/kg of KET can be considered an effective protocol for chemical immobilisation of captive tigers, along with dosage adjusments or when other drugs are needed.

Eikelberg, D. J., Allnoch, L., Grothmann, P., Bohner, J., and Hewicker-Trautwein, M. (2020). Subcutaneous fibrosarcomas with pulmonary metastases in a white tiger (Panthera tigris) and a lion (Panthera leo). Veterinary Record Case Reports, 8, e000960. *https://doi.org/10.1136/vetreccr-2019-000960*

ABSTRACT

Two cases of recurrent subcutaneous fibrosarcomas in a white tiger and a lion were observed and the animals were euthanised humanely due to clinical deterioration. In both animals, postmortem examination revealed multinodular, white to fawn, firm to greasy, subcutaneous masses at the left side of the thorax infiltrating into the adjacent musculature. Furthermore, the tiger showed a single mass and the lion multiple masses in the lung. Histopathologically, the subcutaneous and pulmonary masses consisted of spindle-shaped neoplastic cells with necrotic areas, and infiltration with multinucleated giant cells and lymphocytes. Immunohistochemically, tumour cells labelled positive for vimentin and negative for desmin, factor VIII-related antigen, smooth muscle actin S100, CD31 and nerve growth factor receptor p75. Thus, the pulmonary tumours were diagnosed as metastases of subcutaneous fibrosarcomas. Like domestic cats, also large, non-domestic felids could be predisposed for metastasising fibrosarcoma, which may be associated with injections or trauma.

Georoff, T. A., Ramsay, E. C., Gyimesi, Z. S., Kilburn, J. J., and Sykes, J. M., 4th (2020). Review Of Canine Distemper Vaccination Use and Safety In North American Captive Large Felids (Panthera Spp.) From 2000 To 2017. Journal of zoo and wildlife medicine, 50(4), 778–789. *https://doi.org/10.1638/2018-0163*

ABSTRACT

Data on canine distemper virus (CDV) vaccination were collected on 812 large felids (351 tigers, Panthera tigris; 220 lions, Panthera leo; 143 snow leopards, Panthera uncia; 50 leopards, Panthera pardus; and 48 jaguars, Panthera onca) from 48 institutions to assess vaccine use and safety. The documented individual vaccination events with multiple products numbered 2,846. Canarypox-vectored CDV vaccines were the most commonly used vaccines (96.3% of all vaccinations) and the Purevax® Ferret Distemper (PFD) vaccine was the most commonly used canarypox-vectored vaccine (91.0% of all vaccinations). Modified live virus (MLV) CDV vaccines were used for 3.7% of all vaccinations, and only in tigers, lions, and snow leopards. Adverse effects were reported after 0.5% (13 of 2,740) of the canarypox-vectored vaccinations and after 2.9% (3 of 104) of the MLV CDV vaccinations. This low complication rate suggests large felids may not be as sensitive to adverse effects of MLV CDV vaccines as other exotic carnivores. Serological data were available from 159 individuals (69 tigers, 31 lions, 31 snow leopards, 22 jaguars, and 6 Amur leopards, Panthera pardus orientalis) vaccinated with the PFD vaccine, and 66.0% of vaccinates seroconverted (defined as acquiring a titer ≥1: 24) at some point postvaccination: 24.3% after one vaccination, 55.8% after two vaccinations, 54.3% after three vaccinations, and 79.2% after four or more vaccinations. Among animals exhibiting seroconversion after the initial PFD vaccinations, 88.9% still had titers ≥12 mo and ≥24 mo after the last vaccination, and 87.5% had titers ≥1: 24 at ≥36 mo after the last vaccination. The study was unable to assess fully the safety of vaccination with either canarypox-vectored or MLV CDV vaccines during gestation because of the small number of animals vaccinated while pregnant (n = 6, all vaccinated with PFD).

Krol, L., Vernau, W., Mutlow, A. G., Brady, S. M., Wack, R. F., Kubly, S., Zwingenberger, A. L., Culp, W. T. N., Palm, C., and Rebhun, R. B. (2020). Unusual splenic B-cell lymphoma in two related Sumatran tigers (Panthera tigris sumatrae). Journal of the American Veterinary Medical Association, 257(12), 1288–1293. *https://doi.org/10.2460/javma.257.12.1288*.

ABSTRACT

Case description: A 14-year-old 120-kg (264-lb) sexually intact male Sumatran tiger (Panthera tigris sumatrae) and its 10-year-old 130-kg (286-lb) sexually intact male offspring were housed separately and evaluated independently after experiencing weeks of ongoing malaise, weight loss, and anorexia.

Clinical findings: Both animals were immobilized and anesthetized for physical examinations and diagnostic testing. Complete blood counts revealed leukopenia and anemia in both tigers. Splenomegaly was identified on abdominal ultrasonography. Cytologic examination and immunohistochemical staining of splenic samples confirmed intermediate to large B-cell lymphoma; no evidence of lymphoma in surrounding organs was noted.

Treatment and outcome: The sire was treated with lomustine and prednisolone. This tiger was euthanized 21 months after initiation of treatment because of chronic progressive renal disease. The male offspring was treated with l-asparaginase but did not respond to the treatment. A splenectomy was performed, and malaise and anorexia resolved. No further chemotherapy was administered, and the male offspring was instead maintained on a low dose of prednisolone. Thirty-two months after diagnosis, the male offspring was still considered to be in remission.

Clinical relevance: To our knowledge, this was the first known report of the diagnosis and management of a splenic B-cell lymphoma in a tiger. Both tigers achieved positive clinical responses and long-term survival by means of different treatment modalities. The finding of such an unusual neoplasm in a male tiger and its male offspring was noteworthy, raising the

possibility of a genetic predisposition for this lymphoma type.

Lefebvre, S. L., Wallett, H. M., Dierenfeld, E. S., and Whitehouse-Tedd, K. (2020). Feeding practices and other factors associated with faecal consistency and the frequencies of vomiting and diarrhoea in captive tigers (Panthera tigris). Journal of Applied Animal Nutrition, 8(1), 31-40. *http://dx.doi.org/10.3920/jaan2019.0002*

ABSTRACT

Gastrointestinal (GI) health is important to the welfare of captive tigers, and diet is considered a likely influencing factor. A survey was performed to collect information on GI health indicators and diet of tigers housed in zoologicalcfacilities across the globe. Completed surveys were received for one tiger from each of 32 facilities. Three (9%) tigers were reported as being diagnosed as having current GI disease; 24 (75%) had ideal (soft with shape) faeces 'often' to 'always' during the four weeks before survey completion. Potential associations between current GI disease and other variables could not be explored because of the low disease prevalence. Commercial raw meat diets were the most commonly fed diet type, and the most common food source was horse. Upon multivariate analysis, including country as a covariate, the odds and frequency of vomiting during the previous six months increased with the frequency of feeding muscle meat and chicken, and decreased as the frequency of feeding long bones increased. The odds and frequency of diarrhoea over the previous six months increased with the frequency of feeding beef and muscle meat; and the frequency of liquid faeces in the previous four weeks increased with oral antimicrobial treatment and increasing frequency of feeding beef. Although limited by the small sample size, these findings characterized the nutritional care that captive tigers currently receive and provided preliminary insight into dietary associations with indicators of GI health. The findings support the need to consider species-specific dietary adaptations and for further investigations into the health impact of diet in captive tigers.

McAloose, D., Laverack, M., Wang, L., et al. (2020). From people to Panthera: Natural SARS-CoV-2 infection in tigers and lions at the Bronx Zoo. mBio, 11(5), 1-13. *http://dx.doi.org/10.1128/mbio.02220-20*.

ABSTRACT

The human-animal-environment interface of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is an important aspect of the coronavirus disease 2019 (COVID-19) pandemic that requires robust One Health-based investigations. Despite this, few reports describe natural infections in animals or directly link them to human infections using genomic data. In the present study, we describe the first cases of natural SARS-CoV-2 infection in tigers and lions in the United States and provide epidemiological and genetic evidence for human-to-animal transmission of the virus. Our data show that tigers and lions were infected with different genotypes of SARS-CoV-2, indicating two independent transmission events to the animals. Importantly, infected animals shed infectious virus in respiratory secretions and feces. A better understanding of the susceptibility of animal species to SARS-CoV-2 may help to elucidate transmission mechanisms and identify potential reservoirs and sources of infection that are important in both animal and human health.

McEntire, M., Ramsay, E. C., Kania, S., Prestia, P., Anis, E., Cushing, A. C., and Wilkes, R. P. (2020). Tiger (Panthera Tigris) And Domestic Cat (Felis Catus) Immune Responses to Canarypox-Vectored Canine Distemper Vaccination. Journal of zoo and wildlife medicine, 50(4), 798–802. *https://doi.org/10.1638/2019-0049*.

ABSTRACT

Two methods for delivering a canarypox-vectored canine distemper vaccine to tigers (Panthera tigris) and domestic cats (Felis catus) were investigated. Eight tigers were divided randomly into two vaccination groups: subcutaneous injection or topical tonsillar application. Each tiger received 2 ml of canine distemper virus (CDV) vaccine (Merial Ferret Distemper Vaccine). Blood was collected from tigers on days 0, 21, 35 or 37, and 112 post-initial vaccination (PIV). Domestic cats were divided randomly into four treatment groups: saline injection (negative controls), low- and high-dose oral, and subcutaneous vaccinates. Blood was collected from domestic cats on days 0, 7, 21, and 28 and 165 or 208 PIV. Sera were tested for CDV antibodies by virus neutralization. All individuals were seronegative at the beginning of the study. One tiger vaccinated subcutaneously developed a titer of 32 by day 35, which reduced to 16 by day 112. Another tiger vaccinated by tonsillar application developed a titer of 8 on day 112. All other tigers remained seronegative. Cats that received saline injection or oral vaccination remained seronegative at each sampling time. Domestic cats vaccinated subcutaneously developed titers ranging from 4 to >128 by day 28, and those re-bled at day 166 had titers of 16 or 64. The disparity in response between domestic cats and tigers may be due to species differences or it may represent a dose-dependent effect. Subcutaneous vaccination with canarypox-vectored Purevax Ferret Distemper® is safe and elicits persistent antibody titers in domestic cats vaccinated parenterally.

McEntire, M. S., Ramsay, E. C., Price, J., and Cushing, A. C. (2020). The Effects of Procedure Duration and Atipamezole Administration on Hyperkalemia in Tigers (Panthera Tigris) And Lions (Panthera Leo) Anesthetized With A-2 Agonists. Journal of zoo and wildlife medicine, 51(3), 490–496. *https://doi.org/10.1638/2019-0128*.

ABSTRACT

A retrospective analysis of 40 extended (>2 hr) anesthetic events in eight lions (Panthera leo) and 32 tigers (Panthera tigris) was performed using a hierarchical linear growth curve model to assess the effects of anesthetic time, α-2 adrenoreceptor agonist dosages, administration of atipamezole, and biochemical parameters on rising plasma K+ concentrations. Hyperkalemia was first noted at a mean time of 187 min (range: 131–226 min), with time under anesthesia as a statistically significant predictor of K+ concentration ($P < 0.0001$). A significant two-way interaction between time and atipamezole administration ($P = 0.0082$) for rising K+ concentrations was demonstrated, indicating that administration of atipamezole can mitigate the rise in K+ concentrations. Administration of atipamezole beyond 150 min of anesthetic time was less effective in reducing K+ concentrations than if administered earlier. Electrocardiographic abnormalities were noted in eight animals, including three hyperkalemic individuals. Lions developed significantly greater plasma K+ concentrations than tigers ($P = 0.0009$) during anesthesia. No biochemical parameter was identified as a significant indicator of which individuals will develop hyperkalemia. Clinicians anesthetizing any large nondomestic felid should monitor electrolytes regularly during anesthetic events; consider early, partial- to full-dose reversal of α-2 agonists; and be prepared to correct potentially life-threatening electrocardiographic abnormalities resulting from hyperkalemia.

Mercado, J. A., Romano, J., De la Cueva, H., and Haro, P. (2020). Multiple successful tiletamine-zolazepam-xylazine immobilizations in an Amur tiger cub. Veterinary Record Case Reports, 8, e001081. *https://doi.org/10.1136/vetreccr-2020-001081*

ABSTRACT

Tiletamine-zolazepam immobilisation use in tigers is controversial and has been associated with neurological diseases, poor recoveries and death. Recent publications show this controversy is unsubstantiated. The multiple use of the tiletamine-zolazepam-xylazine (TZ-XZ) combination in a 33-kg Amur tiger (Panthera tigris altaica) cub without adverse reactions is described. The physiological values were not statistically different between anaesthetic events and were comparable with those observed with other protocols. No renal, hepatic or neurological functions were affected during the 10 anaesthetic events over the course of five months. The TZ-XZ (1–1.5 mg/kg + 0.5–1 mg/kg) combination proved to be safe for use in this tiger during repeated immobilisations. The tiger was healthy at the time of the paper's submission. Further studies with a larger population of animals are encouraged.

Narayan, E. (2020). Non-invasive hormone and behavior monitoring in zoo animals to advance welfare: Case study of tigers (Panthera tigris). Thylacinus, 44(2), 6-10
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SUMMARY

The current report focuses on the changes in fecal progesterone metabolites (FPM) in two adult female Bengal tigers (Panthera tigris), comparing between bred and non-bred females.

Proverbio, D., Perego, R., Baggiani, L., Ravasio, G., Giambellini, D., and Spada, E. (2020). Serum Protein Gel Agarose Electrophoresis in Captive Tigers., 10(4), 716. *https://doi.org/10.3390/ani10040716*.

ABSTRACT

Given the endangered status of tigers (Panthera tigris), the health of each individual is important and any data on blood chemistry values can provide valuable information alongside the assessment of physical condition. The nature of tigers in the wild makes it is extremely difficult to obtain biological samples from free-living subjects, therefore the values obtained from captive tigers provide very useful data. Serum protein electrophoresis is a useful tool in the diagnosis and monitoring of a number of diseases. In this study, we evaluated agarose gel serum protein electrophoresis on samples from 11 healthy captive tigers. Serum electrophoresis on all 11 tiger samples successfully separated proteins into albumin, α1, α2, β1, β2 and γ globulin fractions as in other mammals. Electrophoretic patterns were comparable in all tigers. Mean± standard deviation or median and range values obtained for each protein fraction in healthy tigers were, respectively: 3.6 ± 0.2, 0.21 (0.2-0.23), 1.2 ± 0.2, 10.7 ± 0.2, 0.4 (0.3-0.6), 1.2 (1-1.8) gr/dL. The results of this preliminary study provide the first data on serum electrophoretic patterns in tigers and may be a useful diagnostic tool in the health assessment of this endangered species.

Shetty, B. D., Zachariah, A., Farver, T. B., Smith, B., Goldstein, T., and Mazet, J. A. K. (2020). Carnivore Protoparvovirus 1 (Parvoviruses) at The Domestic-Wild Carnivore Interface in India. Journal of zoo and wildlife medicine, 50(4), 1016–1020. *https://doi.org/10.1638/2018-0166*.

ABSTRACT

Carnivore protoparvovirus 1 (CP1, earlier called Feline panleukopenia virus) variants such

as canine parvovirus (CPV) and feline parvovirus (FPV) are significant, emerging, multihost pathogens of domestic and wild carnivores. The diversity of CP1 variants was studied between 2008 and 2014 in Wayanad, India, where flagship wildlife species such as tigers (Panthera tigris) and leopards (Panthera pardus) coexist alongside domestic carnivores, including dogs (Canis lupus familiaris) and cats (Felis catus). Using polymerase chain reaction, FPV and CPV sequences were obtained from the heart blood of a necropsied leopard individual for the first time in the world and from rectal swabs of three sympatric and clinically ill domestic dogs. CP1 amplicons were also detected in a tiger. Cross-species transmission possibilities were identified, as the closest relatives to the leopard FPV sequence were found in domestic cats from a neighboring state.

Veasey, J. S. (2020). Can zoos ever be big enough for large wild animals? A review using an expert panel assessment of the psychological priorities of the Amur tiger (Panthera tigris altaica) as a model species. Animals, 10(9), 1536.

ABSTRACT

The ecology of large, wide-ranging carnivores appears to make them vulnerable to conservation challenges in the wild and welfare challenges in captivity. This poses an ethical dilemma for the zoo community and supports the case that there is a need to reconsider prevailing management paradigms for these species in captivity. Whilst the welfare challenges wide ranging carnivores face have been attributed to reduced ranging opportunities associated with the decreased size of captive habitats, attempts to augment wild carnivore welfare in captivity typically focus on behaviours linked to hunting. Thus far, this has yet to result in the systematic elimination of signs of compromised welfare amongst captive carnivores. Here an assessment is carried out to identify the likely welfare priorities for Amur tigers, which, as one of the widest ranging terrestrial carnivores, serves as an excellent exemplar for species experiencing extreme compression of their ranging opportunities in captivity. These priorities are then used to consider novel strategies to address the welfare challenges associated with existing management paradigms, and in particular, attempt to overcome the issue of restricted space. The insights generated here have wider implications for other species experiencing substantive habitat compression in captivity. It is proposed here that the impact of habitat compression on captive carnivore welfare may not be a consequence of the reduction in habitat size per se, but rather the reduction in cognitive opportunities that likely covary with size, and that this should inform strategies to augment welfare.

INDIA

CONSERVATION, MANAGEMENT AND POLICY RECOMMENDATION

Kamble, Z., Kelkar, P., and Bhati, A. (2020). Displaced due to conservation and tourism in the heart of India: A review of the relevant policies. In A. Kavoura, E. Kefallonitis, and P. Theodoridis (Eds.), Strategic Innovative Marketing and Tourism (pp. 1-12). Springer Proceedings in Business and Economics. *https://doi.org/10.1007/978-3-030-36126-6_78*.

ABSTRACT

Madhya Pradesh (MP) is a central Indian state positioned as the heart of India. The MP tourism board undertakes the responsibility of developing tourism in the state with the aim of promoting sustainable form of tourism. One of the key attractions promoted is the wide range of wildlife destinations in conservation areas, which has displaced many local indigenous communities. The main aim of paper is to review the relevant policies concerning the wildlife tourism product in MP to examine the involvement of the indigenous local communities and highlight their plight due to displacement. This paper utilizes a critical interpretive lens in reviewing the policies and the concerned acts. Findings highlight three areas of concern; firstly, there is a lack of clear information on how wild life tourism would be developed, implemented and governed. Secondly, the relevant policies do not mention the involvement of the local indigenous community or their issues and finally the policies does not clearly address the displaced indigenous communities' issues while subsisting to a sustainable tourism vision. Implications for are discussed.

Rathika Ramasamy

Lopes, A. A., and Atallah, S. (2020). Worshipping the tiger: Modeling non-use existence values of wildlife spiritual services. Environmental and Resource Economics, 76, 69–90. *https://doi.org/10.1007/s10640-020-00416-1*.

ABSTRACT

Several indigenous tribes around the world derive spiritual value from revering fauna and flora species. Species conservation is not a prime objective of such traditions but can be an unintended consequence. Conventional species conservation practices ignore this spiritual value and tribes are often evicted from protected areas. We use the existence value framework to develop a coupled ecological-economic model of the use and non-use, existence values of wildlife for a tribe that derives spiritual value from a wildlife population. We calibrate the model for the Biligiri Rangaswamy Temple (BRT) Tiger Reserve in India with the resident Soligas tribe who consider tigers as sacred and back out an existence value of tigers in this reserve from a tribe manager's perspective. The model ascertains tiger population dynamics under several management scenarios. Steady-state convergence is observed under secure property rights for the Soligas. Scenarios in which they are evicted from the BRT reserve and lose their property rights yields localized tiger extinction. Finally, we generate a marginal existence value function and discuss the potential for using existence value estimates in guiding conservation policy.

Milda, D., Ramesh, T., Kalle, R., Gayathri, V., and Thanikodi, M. (2020). Ranger survey reveals conservation issues across protected and outside protected areas in southern India. Global Ecology and Conservation, 24, e01256. *https://doi.org/10.1016/j.gecco.2020.e01256*.

ABSTRACT

Intensifying human-wildlife interaction requires effective human-wildlife management strategies. In India, forests designated as Protected Areas (PAs) have better wildlife protection measures unlike Reserved Forests (outside PAs) which are undervalued, although both support similar kinds of wildlife. Wildlife conservation planning and policy-level decision making become incomplete without addressing wildlife management issues outside PA along with PAs as the former act as a buffer/corridor for PAs. We conducted a semi-structured questionnaire survey with the Forest Range Officers (FROs) belonging to nine PAs and seven outside PAs across the Western and Eastern Ghats part of Tamil Nadu State, southern India. We collected information on the human-wildlife interactions, mitigation measures carried out, poaching incidents, and availability of manpower and resources. Over 50% of the FROs reported an increase in Human-Wildlife Conflict (HWC) incidents for the past five years. Major species involved in conflict in PAs and outside PAs were elephant (Elephas maximus), wild pig (Sus scrofa), leopard (Panthera pardus), bonnet macaque (Macaca radiata), followed by sloth bear (Melursus ursinus), sambar (Rusa unicolor) (more in PAs), gaur (Bos gaurus) (more in outside PAs), dhole (Cuon alpinus), chital (Axis axis), and tiger (Panthera tigris). There were no variations in the mitigation measures employed in PAs and outside PAs. The number of schemes (N = 8–10) available for wildlife management was similar, but to a certain extent, the fund availability was more insufficient outside PAs than in PAs. Tiger (only in PAs), leopard, elephant, and pangolin (Manis crassicaudata) were amongst the fourteen wildlife species poached in the PAs and outside PAs, although wild pig, sambar, black-naped hare (Lepus nigricollis), and chital dominated the list. Prevalent methods for poaching were snares, trained dogs, guns (dominant in PAs), followed by hand-made bombs, poisoning, cage traps, electric traps (only outside PAs), and food baits. Over 50% of the FROs reported decreases in poaching incidences with improved wildlife management strategies for the past five years. PAs had a higher number of anti-poaching camps with anti-poaching watchers than outside PAs. Our study highlighted the disparity in resource allocation among PAs and outside PAs though the intensity of conservation issues was similar. Inadequate availability of resources affected the effective management of conflict species which leads to increase risk of HWC. This is the first study to highlight the success/failure of human-wildlife management depending on reducing lacunas in management effectiveness of PAs and outside PAs for managing at a larger landscape level beyond PAs.

Nayak, B., Jena, P., and Chaudhury, S. (2020). Public expenditure effectiveness for biodiversity conservation: Understanding the trends for Project Tiger in India. Journal of Forest Economics, 35, 229-265. *https://doi.org/10.1561/112.00000512*.

ABSTRACT

Project Tiger, a flagship programme for conservation of the tiger launched in 1973 in India has expanded over the years in terms of its geographical coverage and volume of expenditure. However, the tiger is still an endangered species in India and conservation efforts face multiple challenges like widespread loss of tiger habitat, decline in the density of prey animals, illegal poaching, humananimal conflicts and revenge killing. This study explores the trends and patterns of government expenditure over the years by reviewing the annual plan of operation of different tiger reserves and examines whether the volume or the pattern of expenditure has any relationship with performance, measured by the change in the number of tigers and occupancy in 28 tiger reserves. Analysis of the financial outlay data in the Annual Plan of Operation of the tiger reserves suggest that habitat improvement, which includes relocation, gets the highest share whereas humananimal conflict and eco-development gets the least, though more than 0.5 million households are located in and around the tiger reserves 0.3 million. Allocations are neither proportional to the size of the reserve nor to the tiger population. The relationships between expenditure categories and tiger populations are explored through a negative binomial

regression model. Among the expenditure categories, expenditure on habitat improvement, excluding relocation, is found to be negatively related to tiger population whereas all other expenditures like infrastructure, protection, and human-animal conflict are positively related.

Soni, V. K. (2020). Wildlife conservation in India: Issues and challenges. Journal of Interdisciplinary Cycle Research, 12(10), 796-802.

ABSTRACT

Wildlife refers to those plants and animal species which live and grow in areas uninhabited by human. It includes all non-domesticated animals and plants including many other organisms and fungi. Wildlife is found in all ecosystems such as forests, plains, grasslands, deserts and all other areas and have a specific and different form of wildlife. But as the human civilizations developed, the domestication of wild animals and plants began for the benefit of human beings and this had a considerable impact on the environment. Due to human activities, many wild animals adapted to the changes in the environment and started to live in a domestic environment along with humans. Examples of such animals are dogs, cats, cows, buffaloes, goats, rodents and a few species of birds etc. As the human activities increased and development took place on a large scale, the wildlife and the ecosystems were seen being affected by it. It was noticed that the exploitation of the wild animals for the benefit of human beings and recreation purposes increased.

Sunder, S. (2020). Coexistence of mining and conservation: Policy lessons from the artisanal diamond mines and adjoining Tiger Reserve of Panna, India. (Master's thesis). University of Delaware, United States.

ABSTRACT

India, historically one of the world's major diamond producers, is no longer a player in the global diamond economy. Nevertheless, diamond mining still occurs in the country, primarily in the greater Panna region of the state of Madhya Pradesh. The mining region borders Panna National Park, a major tiger reserve and conservation zone. In this thesis, based on fieldwork carried out in the summer of 2019, I present a treatment of artisanal and small-scale diamond mining (ASDM) in Panna that considers its social and environmental impacts on society as derived from and perpetuated by its historical, geophysical, institutional, cultural, economic, and ecological influences. I further offer suggestions to reform ASDM in Panna in a manner that prioritizes social equality, economic stability, environmental protection, and ecological conservation while allowing for continued diamond mining.

Warrier, R., Noon, B. R., and Bailey, L. (2020). Agricultural lands offer seasonal habitats to tigers in a human dominated and fragmented landscape in India. Ecosphere, 11(7), e03080. *https://doi.org/10.1002/ecs2.3080*.

ABSTRACT

Conserving wide-ranging large carnivores in human-dominated landscapes is contingent on acknowledging the conservation value of human-modified lands. This is particularly true for tigers (Panthera tigris), now largely dependent on small and fragmented habitats, embedded within densely populated agroecosystems in India. Devising a comprehensive conservation strategy for the species requires an understanding of the temporal patterns of space use by tiger within these human-modified areas. These areas are often characterized by altered prey communities, novel risks resulting from high human densities and seasonally dynamic vegetative cover. Understanding space use within these areas is vital to devising human-tiger conflict prevention measures and for conserving landscape elements critical to maintain functional connectivity between populations. We documented seasonal space-use patterns of tigers in agricultural lands surrounding protected areas in the Central Terai Landscape (CTL) in northern India. We estimated the probability of space use and its drivers by applying dynamic occupancy models that correct for false-positive and false-negative errors to tiger detection\ non-detection data within agricultural areas. These data were generated by conducting local interviews, sign surveys, and camera trapping within 94 randomly selected 2.5-km^2 grid cells. We found that agricultural areas were used with high probability in the winter (0.64; standard error [SE] 0.08), a period of high vegetative cover availability. The use of agricultural lands was lower in the summer (0.56; SE 0.09) and was lowest in the monsoon season (0.21; SE 0.07), tracking a decline in vegetative cover and available habitat across the landscape. Availability of vegetative cover and drainage features positively influenced space use, whereas use declined with increasing distance to protected areas and the extent of human settlements. These findings highlight the role of agricultural areas in providing seasonal habitats for tigers and offer a basis for understanding where tigers and humans co-occur in these landscapes. These findings help expand our current understanding of what constitutes large carnivore habitats to include human-dominated agricultural areas. They underscore the need for greater integration of land-sharing and land-sparing initiatives to conserve large carnivores within human-dominated agroecosystems.

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Ecology

Basak, K., Ahmed, M., Suraj, M., Reddy, B. V., Yadav, O. P., and Mondal, K. (2020). Diet ecology of tigers and leopards in Chhattisgarh, central India. Journal of Threatened Taxa, 12(3), 15289–15300.

ABSTRACT

Wild prey base is a potential regulatory parameter that supports successful propagation and secured long term survival of large predators in their natural habitats. Therefore, low wild prey availability with higher available livestock in or around forest areas often catalyzes livestock depredation by predators that eventually leads to adverse situations to conservation initiatives. Thus understanding the diet ecology of large predators is significant for their conservation in the areas with low prey base. The present study reports the diet ecology of tiger and leopard in Udanti Sitanadi Tiger Reserve and Bhoramdeo Wildlife Sanctuary, in central India to know the effect of wild prey availability on prey predator relationship. We walked line transects to estimate prey abundance in the study areas where we found langur and rhesus macaque to be the most abundant species. Scat analysis showed that despite the scarcity of large and medium ungulates, tiger used wild ungulates including chital and wild pig along with high livestock utilization (39%). Leopards highly used langur (43–50 %) as a prime prey species but were observed to exploit livestock as prey (7–9 %) in both the study areas. Scarcity of wild ungulates and continuous livestock predation by tiger and leopard eventually indicated that the study areas were unable to sustain healthy large predator populations. Developing some strong protection framework and careful implementation of the ungulate augmentation can bring a fruitful result to hold viable populations of tiger and leopard and secure their long term survival in the present study areas in central India, Chhattisgarh.

Ferretti, F., Lovari, S., Lucherini, M., Hayward, M. and Stephens, P.A. (2020). Only the largest terrestrial carnivores increase their dietary breadth with increasing prey richness. Mam Rev, 50: 291-303. *https://doi.org/10.1111/mam.12197*.

ABSTRACT

Animals should adapt their foraging habits, changing their dietary breadth in response to variation in the richness and availability of food resources. Understanding how species modify their dietary breadth according to variation in resource richness would support predictions of their responses to environmental changes that alter prey communities. We evaluated relationships between the dietary breadth of large terrestrial carnivores and the local richness of large prey (defined as the number of species). We tested alternative predictions suggested by ecological and evolutionary theories: with increasing prey richness, species would (1) show a more diverse diet, thus broadening their dietary breadth, or (2) narrow their dietary breadth, indicating specialisation on a smaller number of prey. We collated data from 505 studies of the diets of 12 species of large terrestrial mammalian carnivores to model relationships between two indices of dietary breadth and local prey richness. For the majority of species, we found no evidence for narrowing dietary breadth (i.e. increased specialisation) with increasing prey richness. Although the snow leopard and the dhole appeared to use a lower number of large prey species with increasing prey richness, larger sample sizes are needed to support this result. With increasing prey richness, the five largest carnivores (puma Puma concolor, spotted hyaena Crocuta crocuta, jaguar Panthera onca, lion Panthera leo, and tiger Panthera tigris), plus the Eurasian lynx Lynx lynx and the grey wolf Canis lupus (which are usually top predators in the areas from which data were obtained), showed greater dietary breadth and/or used a greater number of large prey species (i.e. increased generalism). We suggest that dominant large carnivores encounter little competition in expanding their dietary breadth with increasing prey richness; conversely, the dietary niche of subordinate large carnivores is limited by competition with larger, dominant predators. We suggest that, over evolutionary time, resource partitioning is more important in shaping the dietary niche of smaller, inferior competitors than the niche of dominant ones.

Ghosh, J. S. (2020). The Bengal tigers of India. JOJ Wildl Biodivers, 2(5), 555597. *https://doi.org/10.19080/JOJWB.2020.02.555597*

ABSTRACT

The Bengal tigers (Panthera Tigris Tigris) are unique to India and Bangladesh. They are usually found in the mangrove forest of India and Bangladesh especially in the Gangetic delta region of both these countries. They have many unique characteristics like they are great swimmers and can catch their prey in water. With the rapid destruction of the mangroves, attempts are made to create reserve forests which do not have either a river or mangroves plantation.

Harihar, A., Pandav, B., Ghosh-Harihar, M., and Goodrich, J. 2020. Demographic and ecological correlates of a recovering tiger (Panthera tigris) population: Lessons learnt from 13-years of monitoring. Biological Conservation, 252, p.108848.

ABSTRACT

Efforts are on to recover tiger populations range-wide, but we lack suitable metrics to

characterise and evaluate such recoveries. Identifying such metrics requires an understanding of tiger population dynamics and its ecological correlates in either recovering populations or those exposed to anthropogenic influences. We monitored a recovering tiger population from 2004 to 2017 in Rajaji National Park, India. Using photographic data and spatial capture-recapture models in an inviolate site vacated by pastoralists (zone 1), we identified demographic parameters of a recovering population. By contrasting it with a site that is presently occupied by pastoralists (zone 3) and one that is isolated (zone 3), we identified conditions facilitating recovery. In zone 1, connected to a large source population in Corbett Tiger Reserve, density increased from 2.08 tigers/100 km2 to 7.07 tigers/100 km2 corresponding to an annual growth rate of 4.5%. Density also increased in zone 2 (2.6 tigers/100 km2 to 6.22 tigers/100 km2), but estimated apparent survival was 0.47 against 0.81 in zone 1. Recovery in zone 1 was accompanied by increased survival of females, while female tenure was shorter in zone 2. Due to the lack of functional connectivity, tigers in zone 3 are facing local extinction. Our results demonstrate that creating inviolate spaces to secure breeding populations and maintaining landscape-wide connectivity to expand breeding cores is critical for recovery. We highlight that relying solely on population increase may lead to unreliable inferences about population performance and instead suggest tracking survival and female land tenure to qualify recovery and success of conservation interventions.

Krishnakumar, B. M., Nagarajan, R., and Selvan, M. (2020). Prey selection and food habits of the tiger Panthera tigris (Mammalia: Carnivora: Felidae) in Kalakkad-Mundanthurai Tiger Reserve, southern Western Ghats, India. Journal of Threatened Taxa, 12, 15535–15546. *https://doi.org/10.11609/jott.5607.12.5.15535-15546*.

ABSTRACT

The Endangered Tiger Panthera tigris is the largest felid, distributed over 1.1 million km^2 globally. Conservation of Tigers largely depends on the preservation of its natural prey base and habitats. Therefore, the availability of prey and its selection play a major role in the sustainable future of Tigers in the given landscape. The current study assesses the prey selection patterns by Tigers in tropical evergreen forest of the Kalakkad-Mundanthurai Tiger Reserve (KMTR), southern Western Ghats, India. Density of ungulates was assessed by distance sampling (line transect, N = 21) and diet composition of Tigers was evaluated by analysing their faecal samples (N = 66). The study estimated very low ungulate density (26.87 ± 7.41 individuals km-2) with highest density of Gaur Bos gaurus (9.04 individuals km-2) followed by Wild Boar Sus scrofa (8.79 ± 2.73 individuals km-2), whereas, primate density was quite high (45.89 ± 12.48 individuals km-2), with Nilgiri Langur Semnopithecus johnii having the highest density (38.05 ± 10.22 individuals km-2). About 74.62% of the biomass of Gaur constituted in the Tiger's diet,

consumed lesser than its availability, whereas Sambar constituted 16.73% of the Tiger diet consumed proportionally to its availability. Chital Axis axis, Muntjac Muntiacus muntjak, and Indian Chevrotain Moschiola indica were not represented in the Tiger's diet. The current study is the first scientific information on prey selection of the Tiger in KMTR landscape, which will serve as a baseline for its conservation planning and management.

Kumar, A., Karanth, K. U., and Jathanna, D. (2020). Tigers and leopards coexist despite similarities in space use and habitat selection. Scientific Reports, 10(1), 20-23. *https://doi.org/10.1038/s41598-019-57089-4*

ABSTRACT

We assessed the roles of space use and habitat selection in fostering coexistence of large felids using sympatric radio-collared tigers Panthera tigris and leopards P. pardus. We found that intraspecific spatial overlap was 2 to 17 times lower than interspecific overlap and variation in habitat preference was greater between individuals than between species. These results imply that in certain contexts tigers and leopard coexist despite interspecific similarities in space use and habitat selection.

Ramesh, T., Kalle, R., Milda, D., Gayathri, V., Thanikodi, M., Ashish, K., and Giordano, A.J. 2020. Patterns of livestock predation risk by large carnivores in India's Eastern and Western Ghats. Global Ecology and Conservation, 24, p.e01366.

ABSTRACT

Large scale spatial patterns of livestock predation risk from multiple co-predators are fundamental to applied conservation planning. Here, we examined important ecological, social, and landscape attributes explaining spatial patterns of human-carnivore interactions. We used a systematic grid-based framework, across an area of 14,200 km^2 of sixteen Forest Divisions at the human-wildlife interface encompassing Protected Areas, Reserved Forest and Fringe Areas at the human-wildlife interface in the Eastern and Western Ghats, India. The data was collected on livestock depredation incidents from the tiger (Panthera tigris), leopard (Panthera pardus), and dhole (Cuon alpinus) for the past five years, through semi-structured interviews (n = 1460) of local communities. We examined socio-ecological (i.e. livestock abundance and forest dependency) and landscape attributes (i.e. forest cover, climates and topographic) influencing the depredation events from each carnivore species. We found that livestock predation risk by the tiger, leopard and dhole was driven by the size of livestock species, the dependency of local people on the forest, topography, proximity to water body and the forest boundary, precipitation, and forest cover. Risk of predation from leopard and dhole exhibited high spatial overlap, and

predation by leopards was higher than dhole and tiger. Livestock predation by leopard and dhole was frequent in open areas of Reserved Forest and buffer zones, while that from tiger occurred in densely forested core regions of Protected Areas (PAs). Our predictive risk maps (ca. 22,525 km^2) showed species-specific predation patterns, reflected ecological differences among large carnivores with regards to their habitat and spatial partitioning for domestic prey. Our predictive predation risk map and factors associated with livestock predations provides powerful visual guidance and tools for PA managers in developing multi-species conflict mitigation strategies. We recommend diversifying local economic livelihoods and benefit-sharing options for local communities to minimize their forest dependency.

Sadhu, A. (2020). Distribution and Demography of Carnivores in Some Parts of Semi-Arid Landscape of Western India (Doctoral dissertation). Saurashtra University.

SUMMARY

Tiger populations have declined globally due to poaching, prey depletion, and habitat loss. The westernmost tiger population of Ranthambhore in India is typified by bottlenecks, small size, and isolation; problems that plague many large carnivore populations worldwide. Such populations are likely to have depressed demographic parameters and are vulnerable to extinction due to demographic and environmental stochasticity. A combination of techniques that included radio telemetry, camera traps, direct observations, and photo documentation was used to obtain 3492 observations on 97 individually known tigers in Ranthambhore between 2006-2014 to estimate demographic parameters. Tiger density was estimated from systematic camera trap sampling using spatially explicit capture-recapture (SECR) framework and subsequently compared model inferred density with near actual density (since all tigers in RTR were individually known). SECR tiger density was same as actual density and recovered from 4.6 (SE 1.19) to 7.5 (SE 1.25) tigers/100km^2 over the years. Male: female ratio was 0.76 (SE 0.07), and cub: adult tigress ratio at 0.48 (SE 0.12). Average litter size was estimated at 2.24 (SE 0.14). Male recruitment from cub to sub-adult stage (77.8%, SE 2.2) was higher than that of females (62.5%, SE 2.4). However, malerecruitment rate as breeding adults from the sub-adult stage (72.6%, SE 2.0) was lower than females (86.7%, SE 1.3). Annual survival rates, estimated by known-fate models, of cubs (85.4%, CI95% 80.3-90.5%) were lower than that of juvenile (97.0%, CI95% 95.4-98.7%) and sub-adult (96.4%, CI95% 94.0-98.9%) tigers. Adult male (84.8%, CI95% 80.6-89.2%) and female (88.7%, CI95% 85.3-92.2%) annual survival rates were similar. Human-caused mortality was 47% in cubs and 38% in adults. Mean dispersal age was 33.9 months (SE 0.8), males dispersed further (61 km, SE 2) than females (12 km, SE 1.3). Higher age of first iv reproduction (54.5 months, SE 3.7) with longer inter-birth intervals (29.6 months, SE 3.15) was likely to be an effect of high tiger density. Demographic parameters of Ranthambhore tigers were similar to other tiger populations. With no signs of inbreeding depression, there seems to be no imminent need for genetic rescue. The best long-term conservation strategy would be to establish and manage a metapopulation in the Ranthambhore landscape. Maintaining a viable metapopulation structure requires securing the connecting links or corridors between the source and the sink populations. Industrial development and expansion of human land use have caused major fragmentation and degradation of wildlife habitats. Certain human land uses possess as barriers for large carnivore dispersal. The semi-arid tiger populations persist as small islands in a sea of human land use. Dispersal events of 29 tiger individuals from their natal area to established territory were monitored over nine years. Females (n = 13) settled down near to their natal area (<10 km in 75% cases), occupying their mother territories or areas adjacent to that. Males (n = 16) mostly established territories far (>10 km) from their natal areas. Six (five males and one female) long-distance dispersal events from Ranthambhore to the greater landscape were recorded during the study period. The tiger presence points (n = 139 from six individuals) were used to model habitat permeability (species distribution modelling with MaxEnt) for tiger dispersal in the landscape. This surface was further used in CIRCUITSCAPE to delineate potential habitat linkages. The MaxEnt modelling depicted the importance of scrubland-open forest areas, drainage, and rugged areas in terms of preserving connectivity. The ravines of Chambal and its tributaries, often treated as wastelands, act as the key conduit for tiger dispersal in this human-dominated landscape. However, the non-PA status of these habitats is the major challenge for conserving them v from the growing human disturbances and developmental projects. The identified corridors in the landscape need to be given legal sanctity, and restoration of the connectivity bottlenecks are crucial in order to secure dispersal in the landscape. Tiger, being the top predator, shapes the population of other sympatric carnivores through interference competition and intra-guild predation. Theory suggests that subordinate predator like leopard should shift their activity centres (spatial) and activity peaks (temporal) in response to tiger space and time usage. I used camera trap data to estimate the spatially explicit density, space use, and time-activity pattern of leopards. Twospecies occupancy was used to estimate the spatial co-occurrence of tiger and leopard in Ranthambhore. Ranthambhore had high stable leopard density (9.4±2.3 to 10.4±1.5 per 100 km^2). Occupancy analysis did not show any spatial avoidance between tiger and leopard inside the reserve. However, the spatially-explicit photo-capture rates showed leopard avoided areas frequented by tigers. Leopard's site use intensity was higher on the edges of the reserve with moderate human disturbances. Both tiger and leopards were nocturnal, while activity peaks of the two differed by 4-8 hrs. On average, the time interval between a tiger and leopard photo capture at a site was 4-5 hours. Thus, though leopards coexisted with tigers at high densities, they try to avoid lethal encounters with tigers by microscale selection of time for activity and space use. Besides Ranthambhore, I camera trapped other wildlife habitat patches in the larger landscape with varying degree of protection. I used camera trap detection/non-detection data in occupancy framework with covariates to understand factors that may govern carnivore distributions in these areas. Furthermore, the

species presence points were used to model the suitable habitats and to find out factors governing carnivore distribution in the landscape. Site occupancy of striped hyena was estimated at 0.59 (±0.005) of about vi 4000 km^2. Hyena occupancy probability increased with decrease in tiger usage, proximity to water sources, less human disturbances, and near to roads. Leopard occupancy was estimated at 0.66 (±0.004) of about 4000 km^2 and increased with woodland cover, proximity to water sources and lower tiger usage. Out of ~ 4000 km^2, site occupancy of sloth bear was estimated at 0.49 (±0.002). Sloth bear's occupancy probability decreased presence of scrubland-open forest areas in the grid, and positively correlated with proximity to water sources and increasing distance from human settlements. Estimated site occupancy of honey badger was 0.39 (±0.003) out of ~4000 km^2. The site occupancy probability was decreased with increasing distance to water sources and protection, while increased with increasing distance from human settlements. Large tract of suitable habitats outside of the protected area network was found suitable for large carnivores (MaxEnt outcomes). All the large carnivores showed avoidance towards areas very close to human settlements. Presence of scrubland-open forest habitats was the primary determinant for wolf distribution in the landscape. The present studyshowcased one of the very few long-term research on tigers, elaborating their vital rates, survival parameters, and dispersal. The vital rates of Ranthambhore tigers did not depict any evidence of inbreeding depression despite the recent bottlenecks and isolation. As a long-term conservation strategy, this semi-arid tiger population needs to be conserved in a metapopulation framework. Thus, the dispersal linkages modelled using the actual dispersal points of Ranthambhore tigers needs legal sanctity to safeguard the connectivity in the landscape. The species distribution modelling showed the importance of the PAs and also highlighted areas to direct conservation investments outside the protected areas. Many of these areas hold great conservation significance in terms of tiger vii dispersal as well as large carnivore conservation in the landscape. Therefore, conserving these habitats is the need of the hour.

Caracal (Caracal caracal), the name came from 'kara-kulak' (Turkish), explicitly pointed out the distinct ears of the cat. Large-scale habitat destruction & conversion to human habitat-use caused severe range loss and population decline in the Indian subcontinent. Ranthambhore is the last known stronghold of caracal in the entire country. During the period of this study, a decrease in the caracal photo-capture rate was observed.

Singh, R., Pandey, P., Qureshi, Q., Sankar, K., Krausman, P.R., and Goyal, S.P. 2020. Acquisition of vacated home ranges by tigers. Current Science, 119(9), pp.1549-1554.

ABSTRACT

Understanding the social organization and acquisition of potential home ranges in solitary polygamous mammals is important for their management and conservation. However, such information requires a continuous long-term study. Therefore, limited infor-mation is available for mammals from South Asia. We studied the western most distributed Bengal tiger (Panthera tigris) population of Ranthambhore Tiger Reserve (RTR), Rajasthan, India, intensively during 2005–2011 using direct observation and intensive camera trapping-based methods. We examined how the home ranges of deceased tigers would be filled. Nine home ranges of tigers were vacated (two males and seven females) because of death, translocation, emigration and dispersal. Vacated female home ranges were filled by neighbouring tigers; 57% of neighbouring females were related to each other and after females vacated their ranges, their daughters acquired these home ranges. Mother tigers shared their home ranges with their daughters to increase the reproductive success of the latter. The home range of adult male tiger (TM-02) was estimated to be 73 sq. km using camera traps. Vacated male home ranges were filled by four transient individuals that were not related to each other. These data help under-stand the social organization and land tenure system of tigers in semi-arid habitats of India.

Dhritiman Mukherjee

Habitat Ecology

Gehlot, H. (2020). Geospatial modeling of potential habitat of tiger (Panthera tigris tigris) in Corbett-Kosi River corridor of Uttarakhand, India. Journal of Environmental Biology, 41(2), 211-219.

ABSTRACT

The present study attempts to assess the potential habitat of Tiger (Panthera tigris tigris) in Corbett – Kosi River corridor of Uttrakhand State of India using geospatial modelling from April 2008 to September 2010. Maxent modelling was used to generate the habitat suitability maps and the jackknife test of this model was analysed to develop the potential habitat map for Chital, Wild boar, Sambar and Tiger. As per this model, the AUC for training data were found to be 0.809 for chital, 0.0818 for wild boar, 0.746 for sambar nad 0.800 for tiger. According to response curves, the chital, wild boar and sambar as well as tiger preferred low slope and elevation area. Tiger favoured sal mix and teak forest type where sambar presence was highest (48.7 %). Satellite remote sensing technique has been used for mapping different forest types and density classes in this region.

Shanu, S., Upadhyay, S., Roy, A., Chundawat, R.S., and Bhattacharya, S. (2020). Community structures in simplicial complexes: an application to wildlife corridor designing in Central India -- Eastern Ghats landscape complex, India. arXiv: Physics and Society.

ABSTRACT

The concept of simplicial complex from Algebraic Topology is applied to understand and model the flow of genetic information, processes and organisms between the areas of unimpaired habitats to design a network of wildlife corridors for Tigers (Panthera Tigris Tigris) in Central India Eastern Ghats landscape complex. The work extends and improves on a previous work that has made use of the concept of minimum spanning tree obtained from the weighted graph in the focal landscape, which suggested a viable corridor network for the tiger population of the Protected Areas (PAs) in the landscape complex. Centralities of the network identify the habitat patches and the critical parameters that are central to the process of tiger movement across the network. We extend the concept of vertex centrality to that of the simplicial centrality yielding inter-vertices adjacency and connection. As a result, the ecological information propagates expeditiously and even on a local scale in these networks representing a well-integrated and self-explanatory model as a community structure. A simplicial complex network based on the network centralities calculated in the landscape matrix presents a tiger corridor network in the landscape complex that is proposed to correspond better to reality than the previously proposed model. Because of the aforementioned functional and structural properties of the network, the work proposes an ecological network of corridors for the most tenable usage by the tiger populations both in the PAs and outside the PAs in the focal landscape.

History

Bose, S. (2020). Mega Mammals in Ancient India: Rhinos, Tigers, and Elephants (Online ed.). Oxford Academic. *https://doi.org/10.1093/oso/9780190120412.001.0001*

ABSTRACT

The elephant emerges as a pivotal companion ingrained in Indian culture since ancient times, with overwhelming evidence supporting its significance despite occasional gaps. Conversely, evidence for tigers is scarce, likely due to fragile bones hindering preservation. While commonly present, their physical remnants are minimal, despite being depicted in Mohenjo-Daro seals. The rhinoceros, once widespread across the region, witnessed a decline and disappearance from specific areas earlier than previously thought, yet persisted in northern Pakistan until the Mughal period.

Bose's book provides valuable visual aids, including maps illustrating the occurrences of these species during the Mesolithic, Harappan, and Chalcolithic periods. These maps aid comprehension, especially for Western readers unfamiliar with Indian geography. Despite uneven evidence, the book paints a vivid picture of these mammals' historical presence and decline in different regions.

Chez, K. (2020). The Man-Eating Tiger: Wild Animal Politics and Colonial Indian Identity. Victorian Review, 46(2), 277-292. Published by Johns Hopkins University Press. *https://doi.org/10.1353/vcr.2020.0023*

Sharma, V. (2020). Pardhi Criminality in Postcolonial Chhattisgarh—of Tigers, Tribals and Misfits. Studies in History, 36(1), 98-120.

ABSTRACT

Efforts aimed at canvassing the past–present continuum of criminal tribes, though appreciable, have proven to be piecemeal, sporadic and awkward. Avoiding some characteristic pitfalls, a historical anthropology of the Pardhis of Chhattisgarh reveals how geographies that were relatively untouched by a colonial programme of criminalization before independence can become active sites of the same in the post-independence period. In avoiding either extremes of emphasizing absolute continuities or alternatively marking a putative rupture between the (colonial) past and (postcolonial) present, this article makes a case for how the colonial programme frequently mutates with/through a number of other discourses, such as regional state formation, administrative procedures, wildlife conservation, nascent ideas of

tribal development, and democratic struggles, as part of its relentless movement. This article summarizes the effects of the same for the Pardhis at the level of 'history'.

Sood, P. (2020). Bio-Geographical Distribution of Tiger (Panthera Tigris) in Ancient, Medieval and Modern Rajasthan: Study of Plans to Relocate them in Rajasthan. Indian Journal of Environmental Sciences, 21(4), 27-33.

ABSTRACT

Though intimately associated with India the original home of Tiger (Panthera tigris), encompass far wide area. The habitat of the tiger is extensive beats of forests. The state of Rajasthan has an area of 342239 sq.km. a largest state of India. The state of Rajasthan encompasses an area which in history was known by various names. The tiger in Rajasthan is distributed in few pockets as of Sariska and Ranthambore. It has been relocated to area of Mukundara hills (Newly establisher tiger reserve). The past and present distribution of tiger, will enhance our knowledge about the species. The hunting / poaching of tiger, increasing population has led to disappearance of the tiger from many parts of Rajasthan through ages. The present study is an attempt on not only of studying past and present distribution of tiger, on Rajasthan level but also studied relocation plans. The present study is based on analysis of literature available on topic at other places, as museum records etc. visits to various places of planned relocation as well as studies in forests, museum, places, paintings of past was done. As from study of various sources it can be said that Tiger is now found only in Alwar, Sawai Madhopur, Karauli, Bundi, Kota, Dausa districts in contemporary times. Mukundara hills is name to the relocated tiger and is third tiger reserve of Rajasthan.

Morphology

Rajani, C. V., Patki, H. S., Simanta, P., Surjith, K., Deepa, P. M., and Pradeep, M. (2019). Histomorphological differentiation of the skin of leopard (Panthera pardus), leopard cat (Prionailurus bengalensis), Bengal tiger (Panthera tigris), and golden jackal (Canis aureus). Veterinary world, 13(4), 827–832. *https://doi.org/10.14202/vetworld.2020.827-832*.

ABSTRACT

Background and Aim: Leopard (Panthera pardus), leopard cat (Prionailurus bengalensis) Bengal tiger (Panthera tigris), and golden jackal (Canis aureus) are carnivores. Leopard and Bengal tiger are listed in the red list as vulnerable species by the International Union for Conservation of Nature and Natural resources. Leopard cat and golden jackal are grouped under animals of least concern. A wide variation exists in the structure of the skin and pattern of hair follicles among domestic and wild mammals. Thus, the study aims to create a baseline data on the skin of leopard, leopard cat, Bengal tiger, and golden jackal and the data so obtained may form an indispensable tool in wildlife forensics.

Materials and Methods: Skin samples of leopard (n=3), leopard cat (n=4), Bengal tiger (n=3), and golden jackal (n=4) were collected from the Department of Pathology, College of Veterinary and Animal Sciences, Pookode. The samples were processed for paraffin embedding. Horizontal and vertical sections of 5 µm thickness were used for histological staining techniques. Observations on the layers and features of epidermis, hair follicle pattern and glands, namely, sweat and sebaceous were recorded.

Results: Skin comprised an outer epidermis and an inner dermis. Keratinized stratified squamous epithelium made up the epidermis. Stratum basale, stratum spinosum, stratum granulosum, and stratum corneum were discernible in leopard, Bengal tiger, and golden jackal. In leopard cat, stratum basale, stratum spinosum, and stratum corneum were present. Compound hair follicles were a characteristic feature of all species. However, the pattern varied. In leopard, leopard cat and Bengal tiger, a single large primary guard hair was encircled by compound follicles. The number of surrounding compound follicles ranged between five to seven in leopard, two to five in leopard cat, and three to seven in Bengal tiger. Each compound follicle, in turn contained, one to two coarse primary hair follicles and several fine secondary hair follicles. Compound follicles arranged as clusters of three were a salient attribute in jackal. The central follicle was comparatively larger than the lateral ones. Each compound follicle comprised a single long, primary hair, and six to eight smaller secondary hairs.

Conclusion: Histological variation in the skin of the leopard, leopard cat, Bengal tiger, and golden jackal was established. The data form a valuable basis for comparative histology of wild carnivores. Further, the data may be of value in the identification of the unknown skin samples of wild carnivores.

Manoj Dholakia

2020

GENETICS

Mondol, S., Booth, R. K., and Wasser, S. K. (2020). Fecal stress, nutrition and reproductive hormones for monitoring environmental impacts on tigers (Panthera tigris). Conservation Physiology, 8(1).

ABSTRACT

Non-invasive stress and nutritional hormone analysis in relation to ecological and other biological indices have tremendous potential to address environmental disturbance impacts on wildlife health. To this end, we examined the relation between glucocorticoid (GC) and thyroid (T3) hormone indices of disturbance and nutritional stress in response to ACTH and TSH challenges in captive tigers, as well as how reproductive hormones vary by sex and reproductive condition. Glucocorticoid, thyroid, progesterone and androgen assays conducted on high-performance liquid chromatography separated fractions of biologically relevant fecal extracts revealed high cross-reactivity of these assays for their respective biologically relevant fecal hormone metabolites. Both adrenal and thyroid hormone metabolites were elevated in response to ACTH and TSH challenges. However, the adrenal and thyroid hormone responses to ACTH challenge were concurrent, whereas the adrenal response to TSH challenge was delayed relative to thyroid hormone elevation in both males and females. The concurrently elevated T3 in response to ACTH may serve to raise metabolic rate to maximize use of GC-mobilized glucose, whereas the relatively delayed GC rise following TSH challenge may be a response to glucose depletion due to increased metabolic rate associated with elevated T3. Progesterone, testosterone and androstenedione hormone metabolites were significantly elevated during gestation compared to lactation in a female monitored from conception through early lactation. Results suggest that the glucocorticoid, thyroid and reproductive hormone assays we tested can accurately measure the stress, nutrition and reproductive response from tiger feces, providing useful non-invasive tools to assess physiological responses to environmental stressors and their reproductive consequences in the wild.

Singh, K., Rajput, N., Singh, K., Jadav, K.V., Bhandari, R., and Sharma, J. (2020). Application of forensic entomology in carcass examination of royal Bengal tigers (Panthera tigris tigris) in Madhya Pradesh. Journal of entomology and zoology studies, 8, 1756-1759.

ABSTRACT

Royal Bengal Tiger comes under flagship species that focused for wildlife conservation programme in Indian subcontinents owing to their uncompromised habit and habitats. Though the entomological tools has been using since ancient past for homicidal cases but it could not be applied ever for investigation of wildlife crime pertaining to evidence collection for prosecution and conviction of poachers. Most often carcass of free ranging tigers in the protected or unprotected forest areas being locates under badly putrefied or decomposed stages. Thus identification of carcass needs alternative techniques instead of conventional pathological examinations to collect the facts behind the crime scene. During study period, carcasses of tiger of Kanha Tiger Reserve and Pench Tiger Reserve were examined carefully with the assistance of forests officers and veterinary physicians. The biological samples were collected for assessment of postmortem intervals by following standard protocols. The maggots (8-10) from individual carcass were dissected with the help of scalpel under stereoscopic microscope and teguments of the maggots were separated in sterilized container. From each sample DNA was extracted using DNeasy Blood and Tissue kit and amplified for the Cytochrome oxidase subunit I (COI) gene using commercially available specific primers. The PCR products were sequenced unidirectional and the sequence were identified using nucleotide BLAST by NCBI. The occurrence of Chrysomya megacephala (Fabricius, 1794) in both carcasses of tigers envisaged that blow flies of Chrysomya spp. attract earlier towards carcasses and lay eggs around orifices of the animal. The results emphasized the strength of forensic entomology not only for species identification of the blowflies but also useful for knowing the succession waves of forensically important insects in and around the protected forest areas.

Sandesh Kadur

MONITORING AND ASSESSMENT

Baranidharan, K., Vijayabhama, M., and JR, V. (2020). Assessment of tiger corridor between Mudumalai Tiger Reserve and Mukurthi National Park in Nilgiri Biosphere Reserve, India. Journal of Entomology and Zoology Studies, 8, 2239-2243.

ABSTRACT

Conservation of wildlife corridor is an important management strategy to maintain ecological and genetic connectivity. With this background the present investigation was conducted to study the corridor status in between Mudumalai Tiger Reserve and Mukurthi National Park in Tamil Nadu during the period from August 2014 to July 2015. With respect to herbivore population 11 species of herbivores were recorded through direct and indirect evidence in the study area. Regarding the season, the results revealed that herbivore population were maximum in January and lowest in June. Among the herbivore population, the Sambar deer scored maximum density (6.86/Sq km) followed by Spotted deer (6.56/Sq km) and lowest scored by Elephant (1.63/Sq km). Regarding grids, grid number 28 (45) showed maximum number of herbivore sign and grid number 13 (0) showed lowest through direct and indirect evidence. Regarding distribution of carnivore, Tiger (132) was found to be maximum through indirect evidence than Leopard (58). With respect to season, the result showed that January month showed maximum carnivore population and lowest in June. With respect to grids, the carnivore's population in grid number 21 encountered maximum indirect evidences occurring 19 times. With respect to Tiger population, grid number 23 recorded maximum evidences occurring 14 times and for Leopard, grid number 21 showed maximum evidences occurring 9 times. It was found that Tigers used 17 grids as a corridor, from Mudumalai to Mukurthi. The probability of movement took from grid number 3 → 4 → 7 → 10 → 11 → 14 → 15 → 17 →18 → 21 → 22 → 23 → 25 → 28 → 31 → 34 → 35 →36. This was the corridor used by Tiger to move from Mudhumalai to Mukurthi. These grid pathways when monitored regularly and given protection from human intervention, we could protect Tiger population and its expansion in Nilgiri Biosphere Reserve.

Chatterjee, P., Mondal, K., Tripathy, B., and Chandra, K. (2020). First photographic evidence of Panthera tigris from Neora Valley National Park, Central Himalayas, India. Records of the Zoological Survey of India, 120(1), 89-91.

ABSTRACT

Present article reports first photographic evidence of Panthera tigris from Neora Valley National Park. Previous sightings have been occasionally reported from the National Park and its surroundings, whereas the present study is the first scientific study confirming the presence

of this species through photographic evidence. Tiger was camera trapped on a trail in the upper forest region of the National Park at an altitude of 2605m.

Habib, B., Saxena, A., Mahima., Jhala, Y. V., and Rajvanshi, A. (2020). Assessment of impacts of State Highway 33 on flora and fauna of Nagarhole Tiger Reserve, India (TR. No. 10/2020 – Pp 70).

ABSTRACT

As part of the project funded by the National Tiger Conservation Authority, New Delhi, three sites were chosen for study- the Central Indian tiger landscape including major roads cutting across the animal corridors in the landscape, the National Highway 37 (now 715) cutting through the Kaziranga-Karbi Anglong landscape in Assam, and the State Highway 33 passing through the Nagarhole Tiger Reserve, Karnataka. At Nagarhole Tiger reserve, we intended to study the difference in the impacts of the SH 33 along its two stretches – one that is completely closed to traffic (decommissioned segment) and the other stretch that is closed for night time traffic (night traffic closed segment). We compared the floral (tree species composition and richness), and faunal (ungulate group size and composition, habitat use and activity patterns) characteristics along the two road stretches. We found that tree and sapling species richness was found to be higher in the decommissioned road segment as compared to the night traffic closed road segment, both of which comprised predominantly of native vegetation. On the other hand, shrubs and herbs had higher species richness in the night traffic closed road segment. We found higher species richness and cover of grasses, shrubs and herbs in the night traffic closed road segment, which can be attributed to the edge effect. Even though both the segments of the highway under study are homogenous in respect of rainfall regime, forest type and are managed as part of national park under the same management objectives (Gubbi et al. 2012), results of shrub and sapling study indicate that there exists some distinguishing factors along the two segments so as to favor different species. A further detailed study is required to point out the factors responsible. Contrary to the general understanding, invasive species cover for two of the common invasive species (Lantana camara and Eupatorium odoratum) was higher in the area devoid of traffic as compared to the night traffic closed road segment. This can be attributed to increased light intensity on the forest floor due to lower canopy cover in the decommissioned road segment and higher animal activity, who acts as seed dispersers. Lower canopy cover in decommissioned road segment can be the result of breakage of canopy and crushing of new regeneration by higher presence and more frequent activity of large mammals, like elephants. Mean group size of chital was found to be higher in the night traffic closed road segment, whereas mean crowding was higher in the decommissioned road segment. Higher presence of chital in the night traffic closed road segment can be because of availability of more fodder species and less risk of predation. In the decommissioned road segment, chital and wild pig's habitat use is not affected by the distance from the state highway, whereas,

sambar and elephant's habitat choice is determined by distance from the highway. There has been a 16% increase in the traffic volume from 553 vehicles /day in the last 9 years as reported by Gubbi et al. (2012), to 659 ± 139.70 as reported in our study. However, though there has been an increase in the traffic volume, it is at a slower rate as compared to the increase from 2003 to 2010 level. The average speed of vehicles ranged from 27.5 MPH to 35.4 MPH. We found that in the night traffic closed road segment, animals have modified their activity periods to avoid the vehicular traffic. Most of the mammals are either active in the early morning hours before the road is opened for vehicular movement or late evenings after the road is closed. This suggests that there is a difference in activity pattern of these mammals along both the road segments, in order to understand which a further detailed study about behavior modification of mammals in relation to traffic and other road related disturbances needs to be carried out.

Jain, P., Ahmed, R., Rehman, S., et al. (2020). Detecting disturbed forest tracts in the Sariska Tiger Reserve, India, using forest canopy density and fragmentation models. Modeling Earth Systems and Environment, 6, 1373–1385. *https://doi.org/10.1007/s40808-020-00755-4*

ABSTRACT

The paper explored the level of forest disturbance in the Sariska Tiger Reserve (STR) of Indian tropical forest. We acquired single scene image of Landsat-5 (1989) and Landsat-8 (2015) for the analysis. Disturbance map was produced using fragmentation and canopy density models. The map was categorized into high, moderate, low, and undisturbed forest tracts. Spatiotemporal analysis of forest disturbance (1989–2015) revealed that highly disturbed tracts experienced a decrease of 43%, while medium and low disturbed tracts showed an increase of 57% and 30%, respectively. Undisturbed forest tracts witnessed decrease mainly due to a decrease in very high canopy density and increase in forest fragmentation. Within cores I, II and III of STR, undisturbed forest tracts in core I have significantly declined due to increased anthropogenic activities. Thus, the study calls for immediate attention to check forest disturbance in core I of STR. Though the government has initiated relocation program of the villages and restoration of the STR, the execution process has still a long way to achieve the goal. The methodology adopted in this study can effectively be utilized for assessing the forest disturbance tracts at spatial scales.

Jhala, Y. V., Qureshi, Q., & Nayak, A. K. (Eds.). (2020). Status of tigers, copredators and prey in India, 2018. National Tiger Conservation Authority, Government of India, New Delhi, and Wildlife Institute of India, Dehradun.

The information generated by the earlier three cycles of tiger status evaluation exercises resulted in major changes in policy and management of tiger populations and provided scientific data to fully implement provisions of the Wildlife (Protection) Act 1972, as amended

in 2006, in letter and spirit. The major outcomes that were direct or indirect consequence of information generated by the monitoring exercises were 1) tiger landscape conservation plans, 2) designation and notification of inviolate critical core and buffer areas of tiger reserves, 3) identification and declaration of new tiger reserves, 4) recognition of tiger landscapes and the importance of the corridors andtheir physical delineation at the highest levels of governance (Yumnam et al. 2014), 5) integrating tiger conservation with developmental activities using the power of reliable information in a Geographic Information System database, 6) planning reintroduction and supplementation strategies for tigers and 7) to prioritize conservation investments to target unique vulnerable gene pools (Kolipakam et al. 2019). All these provide an opportunity to incorporate conservation objectives supported with sound science based data, on equal footing with economic, sociological, and other values in policy and decision making for the benefit of the society.

The fourth cycle of the assessment was undertaken in 2018 and 2019 using the best available science, technology and analytical tools. The unique feature of this cycle of assessment, in keeping up with “Digital India”, is the development and use of innovative technological tools in collection and processing of data to reduce human errors. In this cycle, recording of primary field data digitally, through mobile phone application M-STrIPES (Monitoring system for tigers - intensive protection and ecological status), that uses GPS to geotag photo-evidences and survey information, made this exercise more accurate. Further, it involved the development of innovative technology like automated segregation of camera trap photographs to species using artificial intelligence and neural network models (software CaTRAT Camera Trap data Repository and Analysis Tool). Program ExtractCompare (Hiby et al. 2009) that fingerprints tigers from their stripe patterns was used to count the number of individual tigers.

Jhala, Y. V., Qureshi, Q., & Yadav, S. P. (2020). Status of leopards in India, 2018. National Tiger Conservation Authority, Government of India, New Delhi, and Wildlife Institute of India, Dehradun. Technical Report TR/2020/16.

Leopards (Panthera pardus) historically inhabited diverse ecosystems across Africa, Asia, and the Middle East. The Indian subspecies, Panthera pardus fusca, is found in various forested habitats but faces threats such as habitat loss, prey depletion, conflict, and poaching. Despite being adaptable, leopards have experienced significant declines in range and population, leading to a change in their conservation status from ‘Near Threatened’ to ‘Vulnerable’ by the IUCN.

In India, the Indian leopard subspecies retains the largest population size and range outside Africa, facing threats such as poaching, habitat loss, prey depletion, and human conflict. Leopards play a crucial role in biodiversity conservation, especially in areas devoid of other large carnivores. Monitoring the status, distribution, and trends of leopards is vital for

informed conservation decisions. The National Tiger Conservation Authority (NTCA) in India, in collaboration with various stakeholders, conducts a national tiger assessment every four years since 2006. The latest assessment in 2018 estimated leopard abundance at 7,910 in forested habitats across 18 tiger-bearing states. The assessment provides essential data for conservation management decisions, offering insights into ecological roles, resource partitioning, and population dynamics. Landscape-wise leopard abundance, along with tiger assessment estimates, serves as a benchmark for future monitoring and contributes to a better understanding of leopard ecology in India.

Jelil, S.N., Gaykar, A., Girkar, N., Vyas, V., Ben, V.C., and Ramesh, K. 2020. Recent record of tiger from Sahaydri Tiger Reserve, India. CATnews, 71, pp.16-17.

ABSTRACT

We report a recent record of the tiger Panthera tigris from the Sahyadri Tiger Re- serve, Maharashtra, India, where the species has become functionally extinct. After a confirmed record of a tiger in 2011, this recent photographic record in 2018 confirms its first re-appearance in the reserve, encouraging the on-going recovery efforts.

Pal, R., Thakur, S., Arya, S., Bhattacharya, T., and Sathyakumar, S. (2020). Mammals of the Bhagirathi basin, Western Himalaya: Understanding distribution along spatial gradients of habitats and disturbances. Oryx, 55(5), 657-667. doi:10.1017/S0030605319001352.

ABSTRACT

Understanding the distribution of wildlife species and their response to diverse anthropogenic pressures is important for conservation planning and management of wildlife space in human-dominated landscapes. Assessments of anthropogenic impacts on mammals of the Indian Himalayan Region have mostly been limited to locations inside protected areas. We studied the occurrence of mammals in an unexplored landscape, the 7,586sqkm Bhagirathi basin, at an altitude of 500-5200 m. The basin encompasses status that are exposed to a range of anthropogenic pressures. Camera trapping at 209 locations during October 2015–September 2017 confirmed the occurrence of species of mammals, nine of which are categorized as threatened (four Vulnerable, five Endangered) and four as Near Threatened on the IUCN Red List. We recorded five mammal species that were hitherto undocumented in Uttarakhand State: the argali Ovis ammon, Tibetan sand fox Vulpes ferrilata, woolly hare Lepus oiostolus, Eurasian lynx Lynx lynx and woolly flying squirrel Eupetaurus cinereus. In addition, we recorded two Endangered species, the dhole Cuon alpinus and tiger Panthera tigris. Threatened species such as the sambar Rusa unicolor, common leopard Panthera pardus and Asiatic black bear Ursus thibetanus occur in a wide variety of habitats despite anthropogenic disturbance. We recorded the snow leopard Panthera uncia in areas with high livestock density but temporally segregated from human activities. The musk deer Moschus spp. and Himalayan brown bear Ursus arctos isabellinus were recorded in subalpine habitats and appeared to be less affected by human and livestock presence. Our findings highlight the potential of the Bhagirathi basin as a stronghold for conservation of several threatened and rare mammal species.

Rather, T. A., Kumar, S., and Khan, J. A. (2020). Multi-scale habitat modelling and predicting change in the distribution of tiger and leopard using random forest algorithm. Scientific Reports, 10, 11473. *https://doi.org/10.1038/s41598-020-68167-z*

ABSTRACT

Tigers and leopards have experienced considerable declines in their population due to habitat loss and fragmentation across their historical ranges. Multi-scale habitat suitability models (HSM) can inform forest managers to aim their conservation efforts at increasing the suitable habitat for tigers by providing information regarding the scale-dependent habitat-species relationships. However the current gap of knowledge about ecological relationships driving species distribution reduces the applicability of traditional and classical statistical approaches such as generalized linear models (GLMs), or occupancy surveys to produce accurate predictive maps. This study investigates the multiscale habitat relationships of tigers and leopards and the impacts of future climate change on their distribution using a machine-learning algorithm random forest (RF). The recent advancements in the machine-learning algorithms provide a powerful tool for building accurate predictive models of species distribution and their habitat relationships even when little ecological knowledge is available about the species. We collected species occurrence data using camera traps and indirect evidence of animal presences (scats) in the field over 2 years of rigorous sampling and used a machine-learning algorithm random forest (RF) to predict the habitat suitability maps of tiger and leopard under current and future climatic scenarios. We developed niche overlap models based on the recently developed statistical approaches to assess the patterns of niche similarity between tigers and leopards. Tiger and leopard utilized habitat resources at the broadest spatial scales (28,000 m). Our model predicted a 23% loss in the suitable habitat of tigers under the RCP 8.5 Scenario (2050). Our study of multi-scale habitat suitability modeling provides valuable information on the species habitat relationships in disturbed and human-dominated landscapes concerning two large felid species of conservation importance. These areas may act as refugee habitats for large carnivores in the future and thus should be the focus of conservation importance. This study may also provide a methodological framework for similar multi-scale and multi-species monitoring programs using robust and more accurate machine learning algorithms such as random forest.

HUMAN WILDLIFE INTERACTION AND CONFLICT MITIGATION

Habib, B., Saxena, A., Jhala, Y. V. and Rajvanshi, A. (2020). Monitoring of animal underpasses on National Highway 44 (Earlier 7) passing through Pench Tiger Reserve, Maharashtra, India (TR. No. 2020/09 – Pp 30).

As part of the project funded by the National Tiger Conservation Authority, New Delhi, three sites were chosen for study- the Central Indian tiger landscape including major roads cutting across the animal corridors in the landscape, the National Highway 37 (now 715) cutting through the Kaziranga-Karbi Anglong landscape in Assam, and the State Highway 33 passing through the Nagarhole Tiger Reserve, Karnataka.

As part of the project, we also monitored the animal underpasses constructed on the National Highway 44 passing through the Pench Tiger reserve, Maharashtra. We used camera traps to capture movement of animals under the nine crossing structures during March-December 2019. We found 18 species of wild animals that were using the crossing structures, with varying frequencies. Seven species of small mammals were found to use the structures. These included Indian hare and jungle cat, which are the most frequent users of the underpasses, and the rare rusty spotted cat. Among wild ungulates, the five major species viz., spotted deer, gaur, nilgai, sambar and wild pig were found to use the structures. Spotted deer and wild pig were the most frequent visitors to the underpasses. Tiger, leopard, wild dog, sloth bear and jackal, the major carnivore species in the landscape, were found using the structures with varying frequencies. Wild dogs were found to use the structures the most, followed by tigers. A total of 89 tiger crossings were recorded from six of the nine structures, by 11 individual tigers.

Internet

Human Dimension

Ajit Debnath. (2020). Social Rejection of Tiger-Widows of Sundarban, India. Journal Of Critical Reviews, 7(15).

ABSTRACT

Human-tiger conflict is a recurrent problem in the Sundarbans Reserve Forest, India. It not only led to a heightened concern for noteworthy morbidity and mortality of the people living in this deltaic region as well as the man-eating tigers. both This study explores the uncanny fate of the widows whose husbands were pounced upon by tigers while going out fishing. The widows of tiger-attacked husbands have to bear with the indelible stigma commensurate with tiger-killing and sequential social rejection and intolerance. The present paper analyses how these social ostracisms led to the development of psychosocial problems of the widows.

Nirmalya Chakraborty

TOURISM

Sharma, S., Sood, S., and Chaudhry, P. (2020). Protected areas, tourism economy and employment generation: A case study from India. Ecological Questions, 31(1), 23-33.

ABSTRACT

Wildlife tourism in the form of Tiger Tourism dominates in India as the country is home to more than half of the world's tiger population. The first tiger reserve was established in India in 1973. At present, there are 50 tiger reserves in the country, which are administered by the National Tiger Conservation Authority (NTCA) at the central level and state forest and wildlife departments at the field level. The present case study concerns the assessment of tourism economy and employment generation in one of the prominent tiger reserves in India, i.e. the Satpura Tiger Reserve of the Madhya Pradesh state. Based on the primary and secondary data, it has been estimated that the expenditure incurred by tourists in the Satpura Tiger Reserve between 2017 and 2018 amounted to INR 1,110 million (equivalent to USD 15,416,666; 1 USD = 72 INR). At the same time, around 127,187 man-days were generated for the nearby local community from the tourism establishments.

Nilanjan Chatterjee

ZOOLOGY AND ANIMAL WELFARE

Ahmed, J., Buragohain, N., Ahmed, N., Mekola, I., Kyarong, S., and Choudhury, B. (2020). First extant record of Royal Bengal Tiger (Panthera tigris) in Dibang valley of Arunachal Pradesh, India with a note on translocation using Xylazine and ketamine anaesthetics. Journal of Entomology and Zoology Studies, 8, 531-533.

ABSTRACT

This paper represents the first documentation of Bengal tiger and challenges encountered during chemical immobilization and translocation of two Bengal tiger cubs in Dibang Valley district, Arunachal Pradesh, India. Two darts of 2 ml volume each were prepared for both the cubs with chemical immobilization drugs viz., xylazine hydrochloride and ketamine hydrochloride at the dose rate of 1.5 mg/kg body weight (Total dose 50 mg or 0.5 ml) and 5 mg/kg body weight (Total dose 150 mg or 1.5 ml) respectively. The cubs were anaesthetised after 20 and 27 minutes of dart injections respectively. Cubs were carefully shifted to the iron cage. The recovery of the cubs was uneventful. This rescue operation confirmed the distribution of Bengal tiger in the hilly snowfall area of Arunachal Pradesh, India.

Patel, R., and Patel, R. (2020). Clinical management of trypanosomiasis in tiger cub: A case report. Journal of Entomology and Zoology Studies, 8(5), 1420-1422.

ABSTRACT

Trypanosomiasis has been reported in large feline population from India and has been responsible for mortality in number of animals of rare species. The present report describes a case of fulminant trypanosomiasis in 10-month old male tiger cub showing high fever, nervous signs involving head pressing, delirium beside vomiting. Trypanosomes were observed in both thick and thin smear of blood. Hematological examination showed total leucocyte count within normal range, severe left shift with 50% of immature band cells and possibility of DIC (severe thrombocytopenia). Uneventfully but far timely management and therapy of animal should have succumb to trypanosomiasis as massive parasitemia and nervous signs were indicator of bad prognosis. Single dose of berenil containing Diminazene aceturate as active ingredient, was injected along with supportive therapy at recommended dose rate for treatment of sick tiger cub.

Ram, H., Nehra, A. K., Banerjee, P. S., Garg, R., Karikalan, M., Pawde, A. M., Sharma, A. K., and Singh, R. K. (2020). Opportunistic parasites associated mortality in a nutritionally compromised young wild Bengal tiger. The Indian Journal of Animal Sciences, 90(4), 543–546. *https://doi.org/10.56093/ijans.v90i4.104191*.

ABSTRACT

Present communication deals with unusual observations made during the post mortem examination of a subadult wild tiger from the Pilibhit Tiger Reserve of Uttar Pradesh (India). Physical examination revealed hide bound condition, dull appearance of body coat, old healed fracture of right radius and septic wound in right forelimb apart from a spine of porcupine piercing the nasal septum causing nose bleeding. Organ-wise inspection revealed presence of Dirofilaria immitis adult worms (n=3) in the right ventricle of the heart, Physaloptera sp. in the stomach, Toxocara cati, Ancylostoma sp., Taenia sp. and Spirometra sp. in the small intestine. Examination of intestinal content revealed eggs of Paragonimus sp. and Trichuris sp. along with large number of Isospora sp. oocysts apart from eggs of Toxocara, Ancylostoma, Taenia and Spirometra. The intensity of worms recovered (parasitic load) from the tiger in the present case was found to be surprising in the sense that despite of specific micro-environment requirement of each parasitic species, host allowed buildup of severe infection of almost all the parasitic genera. This situation might have arisen due to compromised immune status of the tiger due to prolonged starvation because of difficulty in catching the prey. All these parasites are present in the tiger reserve and pose a threat to this priceless animal species, especially if the host is immunocompromised.

Rathika Ramasamy

INDONESIA

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Allen, M. L., Sibarani, M. C., Utoyo, L., and Krofel, M. (2020). Terrestrial mammal community richness and temporal overlap between tigers and other carnivores in Bukit Barisan Selatan National Park, Sumatra. Animal Biodiversity and Conservation, 43(1), 97-107.

ABSTRACT

Rapid and widespread biodiversity losses around the world make it important to survey and monitor endangered species, especially in biodiversity hotspots. Bukit Barisan Selatan National Park (BBSNP) is one of the largest conserved areas on the island of Sumatra, and is important for the conservation of many threatened species. Sumatran tigers (Panthera tigris sumatrae) are critically endangered and serve as an umbrella species for conservation, but may also affect the activity and distribution of other carnivores. We deployed camera traps for 8 years in an area of Bukit Barisan Selatan National Park (BBSNP) with little human activity to document the local terrestrial mammal community and investigate tiger spatial and temporal overlap with other carnivore species. We detected 39 mammal species including Sumatran tiger and several other threatened mammals. Annual species richness averaged 21.5 (range 19-24) mammals, and remained stable over time. The mammal order significantly affected annual detection of species and the number of cameras where a species was detected, while species conservation status did not. Tigers exhibited a diurnal activity pattern, and had the highest temporal overlap with marbled cats (Pardofelis marmorata), dholes (Cuon alpinus), and Malayan sun bears (Helarctos malayanus), but little overlap with other carnivores. These findings suggest that some smaller carnivores might be adjusting temporal activity to avoid tigers or mesocarnivores. The stable trends in richness of terrestrial mammal species show that BBSNP remains an important hotspot for the conservation of biodiversity.

CONSERVATION, MANAGEMENT AND POLICY RECOMMENDATION

Haidir, I.A., Kaszta, Ż., Sousa, L.L. et al. (2020). Felids, forest and farmland: identifying high priority conservation areas in Sumatra. Landscape Ecology 36, 475–495. *https://doi.org/10.1007/s10980-020-01146-x*.

Context: Effective planning for protected areas and wildlife population management requires a firm understanding of the location of the species' core habitat patches, the dispersal corridors connecting them, and the risk they face from key threats, notably deforestation.

Objectives: To quantify and map core habitat patches and dispersal corridors for Sunda clouded leopard (Neofelis diardi diardi), Asiatic golden cat (Catopuma temminckii) and marbled cat (Pardofelis marmorata) across the 16,000 km² tropical rainforest Kerinci Seblat landscape, Sumatra. Also, to model future forest loss and fragmentation and its effect on landscape connectivity for populations of these threatened species.
Methods: Using data from camera trap (671 sites/55,856 trap nights), and occupancy modelling, we developed habitat use maps and converted these into species-specific landscape resistance layers. We applied cumulative resistant kernels to map core areas and we used factorial least-cost paths to define dispersal corridors. A 17-year deforestation dataset was used to predict deforestation risk towards the integrity of corridors and core areas.
Results: The occupancy estimates of the three cats were similar (0.18–0.29), with preference shown for habitats with dense tree cover, medium elevation and low human disturbance. The overlap between core areas and corridors across the three species was moderate, 7–11% and 10%, respectively. We predicted future loss of 1052 km² of forest in the landscape, of which 2–4% and 5% in highly importance core areas and corridors.
Conclusions: This study provides a valuable guidance for identifying priority areas in need of urgent protection within and outside the protected area network, and where infrastructure development planning can incorporate wildlife conservation goals.

Adu, S. J., Salampessy, M. L., and Iskandar, S. (2020). Persepsi Masyarakat Terhadap Konservasi Harimau Sumatera (Panthera Tigris Sumatrae) Di Taman Nasional Kerinci Seblat (Studi Kasus Desa Pungut Mudik Dan Desa Pungut Hilir). [Perceptions of the community on Sumatran tiger (Panthera Tigris Sumatrae) conservation in Kerinci Seblat National Park (Case study of Pungut Mudik and Pungut Hilir villages)]. (19)1: 22-29.

ABSTRACT

Perceptions and community participation in Sumatran tigers (Panthera tigris sumatrae) also influence the success of conservation efforts. For this reason, this study aims to describe the level of public perception of Sumatran tiger conservation efforts. This research uses the case study method. Data was collected using a questionnaire, in-depth interviews and focus group discussions (FGD). Data collection was carried out by means of purposive sampling involving 30 respondents, namely farmers who live and move around the national park. The data collected was analyzed descriptively qualitatively. The results of this study indicate that public knowledge about tigers as animals protected by law has perceptions in the high category (4.03), public knowledge about tiger behavior has a high category (3.93) and public knowledge that tigers currently lack food so often seen in villages that have a very high categorization (4.4). In addition, community knowledge about the ecological benefits of the presenceof Sumatran tigers in the environment has a high category (3.90), public knowledge about the economic benefits of the existence of Sumatran tigers has a high category (3,53). Likewise with public knowledge about the social benefits of the existence of Sumatran tigers have a high category (3.67). The government and various parties are urgently needed to increase the understanding and active role of the community for Sumatran tiger conservation efforts.

MONITORING AND ASSESSMENT

Sulistiyono, N., Rambe, B. A., Patana, P., and Purwoko, A. (2020). Spatial model of the Sumatran tigers (Panthera tigris sumatrae) prey habitat suitability index in Besitang. IOP Conference Series: Earth and Environmental Science, 454, 012093.

ABSTRACT

The Besitang forest landscape is a habitat for Sumatran tigers (Panthera tigris sumatrae) which is one of the key species in Gunung Leuser National Park (GLNP). Deforestation and degradation have caused forest fragmentation so that Sumatran tigers habitat becomes narrow. As the first step in modelling the suitability of Sumatran tiger habitat, it is then knowing the distribution of Sumatran tiger prey needs to be done. The objective of this study was to get information about the suitability distribution of Sumatran tigers' prey based on biophysic and social factors in Besitang. The Principal Component Analysis (PCA) method is used to select and weight the factors that are thought to influence the distribution of Sumatran tiger prey. Overlay analysis of the factors that influence the habitat suitability is done using Geographic Information System (GIS). The results showed that the index value of habitat suitability of Sumatran tigers' prey has a range of values from 0 to 1. Areas that have values getting closer to number 1 indicate the area is more suitable for the habitat of Sumatran tiger prey.

Rathika Ramasamy

MALAYSIA

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Behaviour

Hamdan, A., Ab Latip, M. Q., Abu Hassim, H., Mohd Noor, M. H., Tengku Azizan, T. R. P., Mohamed Mustapha, N., and Ahmad, H. (2020). A preliminary study of mirror-induced self-directed behaviour on wildlife at the Royal Belum Rainforest Malaysia. Scientific Reports, 10(1), 14105. *https://doi.org/10.1038/s41598-020-71047-1*.

ABSTRACT

Mirror-induced behaviour has been described as a cognitive ability of an animal to self-direct their image in front of the mirror. Most animals when exposed to a mirror responded with a social interactive behaviour such as aggressiveness, exploratory and repetitive behaviour. The objective of this study is to determine the mirror-induced self-directed behaviour on wildlife at the Royal Belum Rainforest, Malaysia. Wildlife species at the Royal Belum Rainforest were identified using a camera traps from pre-determined natural saltlick locations. Acrylic mirrors with steel frame were placed facing the two saltlicks (Sira Batu and Sira Tanah) and the camera traps with motion-detecting infrared sensor were placed at strategically hidden spot. The behavioural data of the animal response to the mirror were analysed using an ethogram procedure. Results showed that barking deer was the species showing the highest interaction in front of the mirror. Elephants displayed self-directed response through inspecting behaviour via usage of their trunk and legs while interacting to the mirror. Interestingly, the Malayan tapir showed startled behaviour during their interaction with the mirror. However, the absence of interactive behaviour of the Malayan tiger signalled a likelihood of a decreased social response behaviour. These results suggested that the ability to self-directed in front of the mirror is most likely related to the new approach to study the neural mechanism and its level of stimulus response in wildlife. In conclusion, research on mirror-induced self-directed behaviour in wildlife will have profound implications in understanding the cognitive ability of wildlife as an effort to enhance the management strategies and conservation.

MONITORING AND ASSESSMENT

Clements, G. R., Rostro-García, S., Kamler, J. F., Liang, S. H., and Abu Hashim, A. K. b. (2020). Conservation status of large mammals in protected and logged forests of the greater Taman Negara Landscape, Peninsular Malaysia. Biodiversitas Journal of Biological Diversity, 22(1), 272-277. *http://dx.doi.org/10.13057/biodiv/d220133*.

ABSTRACT

Conservation status of large mammals in protected and logged forests of the greater Taman Negara Landscape, Peninsular Malaysia. Biodiversitas 22: 272-277. Peninsular Malaysia contains a large community of IUCN Threatened mammal species, although recent records in some protected areas is unknown. The greater Taman Negara Landscape is one of the national priority areas for tiger conservation, but the recent occurrence of large mammals in the landscape has not been sufficiently updated. Here, we conducted systematic camera-trap surveys in protected and logged forests of the Taman Negara Landscape: Merapoh in Taman Negara National Park (TNM), and the Dungun Timber Complex (DTC), respectively. We found that the diversity of large mammals in TNM appeared to be the same between 2000 and 2016. The detection frequencies (DF) of several Threatened species, such as Malayan tiger (Panthera tigris jacksoni), dhole (Cuon alpinus), and Malayan pangolin (Manis javanica), were similar between surveys, suggesting the relative abundance of these species likely remained stable during the past 16 years. However, the DF of Asian elephant (Elephas maximus) and Malayan tapir (Tapirus indicus) were lower compared to 2000. In DTC, overall mammalian diversity was relatively lower than in TNM, primarily due to the non-detection of two large ungulates: gaur (Bos gaurus) and sambar (Rusa unicolor). Nevertheless, we recorded several other Threatened species of mammals, suggesting there is potential for this forest reserve to preserve some of Peninsular Malaysia's most Threatened mammal species. Our results suggest that the Taman Negara Landscape is still an important global site for the conservation of several Threatened species, and we recommend an increase in wildlife law enforcement efforts to ensure the survival of its large and diverse mammalian community.

Shibu Nair

MYANMAR

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Ecology

Naing, H., Htun, S., Kamler, J. F., Burnham, D., and Macdonald, D. W. (2020). Large carnivores as potential predators of sun bears. Ursus, 30(4), 51-57.

ABSTRACT

Sun bears (Helarctos malayanus) have a wide distribution in Southeast Asia, but little is known about their natural predators. During a camera-trap survey in 2018 in Htamanthi Wildlife Sanctuary, Myanmar, we photographed a male leopard (Panthera pardus) carrying a sun bear cub by the throat. This is the first reported case of probable predation on sun bears by leopards, and only their second confirmed predator. A literature review showed that consumption of sun bears and Asiatic black bears (Ursus thibetanus) by tigers (P. tigris) was widespread in Southeast Asia, whereas consumption of both bear species by leopards and dholes (Cuon alpinus) was less common. Outside of Southeast Asia, tigers and leopards, but not dholes, were shown to kill or consume other bear species. Future research should examine interspecific relationships between sun bears and large felids to better understand what, if any, impacts large felids have on sun bear ecology.

Shibu Nair

NEPAL

HUMAN-WILDLIFE INTERACTION AND CONFLICT MITIGATION

Bhattarai, B. (2020). Conflict and conservation: Sharing the costs and benefits of tiger (Panthera tigris) conservation in communities adjacent to tiger reserves in Nepal (Doctoral dissertation), Federation University, Australia.

ABSTRACT

The study also assessed the potential to redistribute financial benefits accruing from predator conservation to those who bear the costs of conservation due to HWC. Data were sourced through interviews with 422 local households and direct observations of 310 conflict events. Interview participants reported losses of livestock (during previous 5 years) and crops (during previous 1 year). Direct observation data collated livestock (5 communities) and crop losses (7 communities) for 12 months. Willingness to pay surveys were conducted with park visitors (N=387) and tourism business owners (N=74). Results show that tigers are involved in significantly fewer depredation events compared to leopards. This was most obvious in the direct observation data. Leopards killed smaller and medium sized livestock whereas tigers selected both small to medium and large livestock. More depredation events occurred in livestock corrals relative to forest zones or crop fields. Prey species of tigers and leopards (wild boar and chital) were involved more frequently in crop raiding events, and caused more crop damage, compared to megaherbivores such as elephant and rhinoceros. Quantities of crops lost per household were lowest where effective physical barriers were present. Park visitors and tourism business owners indicated willingness to pay for conservation of tigers and for compensation of farmers for their losses. Study findings support several key recommendations to mitigate HWC effects in the study area. These include financial support for local communities to build predator proof livestock corrals and establishment of effective physical barriers at the park borders. A tariff for park visitors and a levy for tourism business owners are also recommended to fund tiger conservation and support financial compensation for farmers affected by HWC.

Fitzmaurice, A., Lamichhane, B., and Poudel, P. (2020). Complex consequences of conservation success: Emerging human-tiger conflicts in Nepal,72, 23-27.

ABSTRACT

Between 1910 and 2010, range-wide tiger populations plummeted from around 100,000 to an estimated 3,200. Poaching, habitat destruction and human-wildlife conflict have all contributed

to this dramatic decrease. In Nepal, the Bardia-Banke Complex, consisting of Bardia National Park (BNP) and Banke National Park (BaNP) and their buffer-zones, is a critical habitat to the Bengal tiger Panthera tigris. Conservation efforts in recent decades have contributed to increasing the tiger population. Despite this increase, no human fatalities associated with human-tiger conflict were reported in the decade prior to 2019: a crucial feature of conservation success. In 2019, ten reported human-tiger incidents resulted in seven human fatalities, three people badly injured, and one tiger taken into captivity. The question of why conflicts involving humans and tigers have suddenly increased requires urgent answers to inform future policy. The development and implementation of case-specific coexistence strategies is a prerequisite to the conservation of this iconic species. This paper explores the complex unintended consequences of conservation success and critically evaluates the circumstances that may explain this recent surge in human deaths and injuries.

CONSERVATION, MANAGEMENT AND POLICY RECOMMENDATION

Illegal Trade

Paudel, P.K., Acharya, K.P., Baral, H.S., Heinen, J.T., and Jnawali, S.R. (2020). Trends, patterns, and networks of illicit wildlife trade in Nepal: A national synthesis. Conservation Science and Practice, 2:e247.

ABSTRACT

Illicit wildlife trade may have devastating consequences for Nepal's wildlife populations given its increasing national and global connectivity and proximity with large Indian and Chinese markets. Despite its potential impacts, our understanding about trends, patterns and networks of illicit wildlife trade in Nepal is very limited. Here, we provide a thorough and comprehensive national assessment of such trade in Nepal using 5 years (2011 through 2015) of data on wildlife seizures and arrests (n = 830) collected from 73 districts. Nearly 87% of arrests included seizures, and globally threatened species were confiscated from 56% of total arrests. There were increasing trends of arrest cases over the time period for all species (p = 0.03), leopards (p = 0.02) and red pandas (p = 0.002), and a decreasing trend for rhinoceros (p = 0.04). Seizures of multiple species—especially tigers, leopards, and pangolin—in arrest cases were suggestive of international organized criminal linkages, whereas individual small-scale seizures were likely for local, species-specific markets. The trade networks suggested connections between species core habitats (poaching sites), cities (collection sites), and transit routes between India and China (international markets). Our results show that wildlife trade, except for rhinoceros, is increasing and trade nodes along districts bordering China and India are suggestive of large, international networks.

MONITORING AND ASSESSMENT

Kc, K., Bhumpakphan, N., Trisurat, Y., Mainmit, N., Ghimire, K., and Subedi, M. (2020). Analysis of Potential Distribution of Tiger Habitat using MaxEnt in Chitwan National Park, Nepal. Journal of Remote Sensing and GIS Association of Thailand, 21(3), 1-15.

ABSTRACT

Bengal Tiger (Panthera tigris tigris) is both an iconic and an umbrella species. Habitat loss, low-prey base, poaching, and illegal trade of its body parts are the main threats for this species. The government of Nepal is committed to fulfilling the international pledge of doubling the tiger population by 2022. At present, there are 93 individual tigers in Chitwan National Park (CNP), each with an average home range of 54 km 2. This research aims to evaluate the existing and potential future habitat and besides analyze the shift in habitat for the Tiger at CNP based on a set of field-based data and environmental variables. Tiger's occurrences in CNP were collected using the camera trapping method. There were 173 tiger occurrence points, which were later separated into a training model (75%) and testing (25%) data. The Maximum Entropy (MaxEnt) model was used to predict potential tiger habitat distribution. The area under the curve (AUC) of receiver operating characteristic was 0.80 and 0.79 for present and future distributions, respectively. Simultaneously, the overall accuracy derived from the logistic threshold maximum training sensitivity plus specificity with the cutoff value of 0.36 for binary classification was 89%. The model results indicated that considerable factors for tiger distribution include distance to grassland (22%), distance to the lake (15%), prey density (12%), and annual mean temperature (11%). Suitable habitats at present cover approximately 59% of the CNP area and will slightly reduce to 55% in 2050 due to climate change. Approximately 28% of suitable tiger habitats will shift from present distributions. Based on the present number of tigers in the CNP area and available habitats both inside the park and in the buffer zone, the maximum number of tigers would not exceed 136 individuals or an increase of 50% from the baseline. Under this situation, this would significantly increase the risk of human-tiger conflicts. Besides, it is crucial to improve the habitat of tigers and prey species both inside the park and in the buffer zone and to promote coexistence between humans and tigers.

RUSSIA

ZOOLOGY AND ANIMAL WELFARE

Gilbert, M., Sulikhan, N., Uphyrkina, O., Goncharuk, M., Kerley, L., Castro, E. H., Reeve, R., Seimon, T., McAloose, D., Seryodkin, I. V., Naidenko, S. V., Davis, C. A., Wilkie, G. S., Vattipally, S. B., Adamson, W. E., Hinds, C., Thomson, E. C., Willett, B. J., Hosie, M. J., Logan, N., ... Cleaveland, S. (2020). Distemper, extinction, and vaccination of the Amur tiger. Proceedings of the National Academy of Sciences of the United States of America, 117(50), 31954–31962. *https://doi.org/10.1073/pnas.2000153117*

ABSTRACT

Canine distemper virus (CDV) has recently emerged as an extinction threat for the endangered Amur tiger (Panthera tigris altaica). CDV is vaccine-preventable, and control strategies could require vaccination of domestic dogs and/or wildlife populations. However, vaccination of endangered wildlife remains controversial, which has led to a focus on interventions in domestic dogs, often assumed to be the source of infection. Effective decision making requires an understanding of the true reservoir dynamics, which poses substantial challenges in remote areas with diverse host communities. We carried out serological, demographic, and phylogenetic studies of dog and wildlife populations in the Russian Far East to show that a number of wildlife species are more important than dogs, both in maintaining CDV and as sources of infection for tigers. Critically, therefore, because CDV circulates among multiple wildlife sources, dog vaccination alone would not be effective at protecting tigers. We show, however, that low-coverage vaccination of tigers themselves is feasible and would produce substantive reductions in extinction risks. Vaccination of endangered wildlife provides a valuable component of conservation strategies for endangered species.

Podturkin, A. A., and Papaeva, N. (2020). Development of an environmental enrichment programme: Case study of white Bengal tiger (Panthera tigris bengalensis) and jaguar (Panthera onca) at Moscow Zoo. Journal of Zoo and Aquarium Research, 8(2), 139–145. *https://doi.org/10.19227/jzar.v8i2.393*

ABSTRACT

Zoos are urged to implement enrichment programmes that include constant feedback to increase efficacy. However, such work is time consuming for zookeepers. The goal of this case study was to establish an enrichment programme in Moscow Zoo that could be used by keepers with minimal effort. In this brief study, an enrichment programme was established for one female white Bengal tiger (Panthera tigris bengalensis) and one female jaguar (Panthera onca). Observations were recorded from February through March 2015. The effects of three enrichment regimes were evaluated: Baseline (routine husbandry: familiar or novel items once or twice a week) compared with two novel intensive regimes: Regime 1 (enrichment provided every day) and Regime 2 (enrichment provided every other day). Two simple methods were used to evaluate the effects of regimes: the "multi-point scan" method where animals' behaviour was recorded 6 times a day by the keepers as they passed the exhibits during their working day, and "SPIDER indirect scales". It was found that the use of both methods for documenting behaviour improved the accuracy of evaluations. During Regimes 1 and 2, behaviour directed at enrichment increased for the tiger and jaguar, but changes in general activity were identified only for the tiger. Consequently, the keepers were able to develop an enrichment programme, including the collection of objective empirical data in a time-efficient manner. It is therefore proposed that zoological institutions use enrichment programmes that integrate both "SPI" and "DER" steps into daily work.

Marcel Langthim from Pixabay

THAILAND

MONITORING AND ASSESSMENT

Ash, E., Hallam, C., Chanteap, P., Kaszta, Ż., Macdonald, D. W., Rojanachinda, W., Redford, T., and Harihar, A. (2020). Estimating the density of a globally important tiger (Panthera tigris) population: Using simulations to evaluate survey design in Eastern Thailand. Biological Conservation, 241, 108349. *https://doi.org/10.1016/j.biocon.2019.108349*

ABSTRACT

Spatially explicit capture-recapture analysis is widely utilized for estimating densities of tigers (Panthera tigris). However, developing a robust study design capable of meeting assumptions and achieving study objectives may be difficult, particularly for low-density populations. Study design decisions for such fieldwork can be aided by simulations. Our goal was to (1) use simulations to investigate and evaluate study design and (2) generate a reliable estimate of density for a population of tigers in Thailand's Dong Phayayen-Khao Yai forest complex. Scenarios were parameterized with a range of potential density estimates (D ^) and detection function parameters (g0 and σ). We designed a field-based trap configuration identified and compared it with simulated performance of a regular trapping array, over 45-day and 60-day sampling occasions. We compared simulation results (i.e. number of individuals [n], detections [ndet], relative standard error [RSE] and relative bias [RB]) and identified that the non-regular trapping array deployed for 60 sampling days would generate reliable density estimates. Our survey produced a density estimate of 0.63 ± SE0.22; (0.32–1.21) tigers per 100 km^2, from a model incorporating variation in sex for g0 and σ, and a population estimate of 20 (14–33). Simulations closely reflected actual results under the null model. Our survey design performed reasonably well, generating a sufficient number of detections and individuals to estimate density of a globally important tiger population. Our results suggest simulations and use of non-regular trap arrays may be beneficial for areas with low species density in which generating sufficient detections is particularly challenging. with low species density in which generating sufficient detections is particularly challenging.

Ash, E., Kaszta, Ż., Noochdumrong, A., Redford, T., Chanteap, P., Hallam, C., and Macdonald, D. (2020). Opportunity for Thailand's forgotten tigers: Assessment of the Indochinese tiger Panthera tigris corbetti and its prey with camera-trap surveys. Oryx, 55(2), 204-211. doi:10.1017/S0030605319000589.

ABSTRACT

Dramatic population declines threaten the Endangered Indochinese tiger Panthera tigris corbetti with extinction. Thailand now plays a critical role in its conservation, as there are few known breeding populations in other range countries. Thailand's Dong Phayayen-Khao Yai Forest Complex is recognized as an important tiger recovery site, but it remains poorly studied. Here, we present results from the first camera-trap study focused on tigers and implemented across all protected areas in this landscape. Our goal was to assess tiger and prey populations across the five protected areas of this forest complex, reviewing discernible patterns in rates of detection. We conducted camera-trap surveys opportunistically during 2008–2017. We recorded 1,726 detections of tigers in 79,909 camera-trap nights. Among these were at least 16 adults and six cubs/juveniles from four breeding females. Detection rates of both tigers and potential prey species varied considerably between protected areas over the study period. Our findings suggest heterogeneity in tiger distribution across this relatively continuous landscape, potentially influenced by distribution of key prey species. This study indicates that the Dong Phayayen-Khao Yai Forest Complex is one of the few remaining breeding locations of the Indochinese tiger. Despite limitations posed by our study design, our findings have catalysed increased research and conservation interest in this globally important population at a critical time for tiger conservation in South-east Asia.

ZOOLOGY AND ANIMAL WELFARE

Areewong, C., Rittipornlertrak, A., Nambooppha, B., Fhaikrue, I., Singhla, T., Sodarat, C., Prachasilchai, W., Vongchan, P., and Sthitmatee, N. (2020). Evaluation of an in-house indirect enzyme-linked immunosorbent assay of feline panleukopenia VP2 subunit antigen in comparison to hemagglutination inhibition assay to monitor tiger antibody levels by Bayesian approach. BMC Veterinary Research, 16(1), 275. *https://doi.org/10.1186/s12917-020-02496-z*

ABSTRACT

Background: Feline panleukopenia virus (FPV) is an etiologic pathogen of feline panleukopenia that infects all members of Felidae including tigers (Panthera tigris). Vaccinations against FPV among wild felid species have long been practiced in zoos worldwide. However, few studies have assessed the tiger immune response post-vaccination due to the absence of

a serological diagnostic tool. To address these limitations, this study aimed to develop an in-house indirect enzyme-linked immunosorbent assay (ELISA) for the monitoring of tiger antibody levels against the feline panleukopenia vaccine by employing the synthesized subunit capsid protein VP2. An in-house horseradish peroxidase (HRP) conjugated rabbit anti-tiger immunoglobulin G (IgG) polyclonal antibody (HRP-anti-tiger IgG) was produced in this study and employed in the assay. It was then compared to a commercial HRP-conjugated goat anti-cat IgG (HRPanti- cat IgG). Sensitivity and specificity were evaluated using the Bayesian model with preferential conditional dependence between HRP-conjugated antibody-based ELISAs and hemagglutination-inhibition (HI) tests.

Results: The posterior estimates for sensitivity and specificity of two indirect ELISA HRP-conjugated antibodies were higher than those of the HI test. The sensitivity and specificity of the indirect ELISA for HRP-anti-tiger IgG and HRP-anticat IgG were 86.5, 57.2 and 86.7%, 64.6%, respectively, while the results of the HI test were 79.1 and 54.1%. In applications, 89.6% (198/221) and 89.1% (197/221) of the tiger serum samples were determined to be seropositive by indirect ELISA testing against HRP-anti-tiger and HRP-anti-cat, respectively.

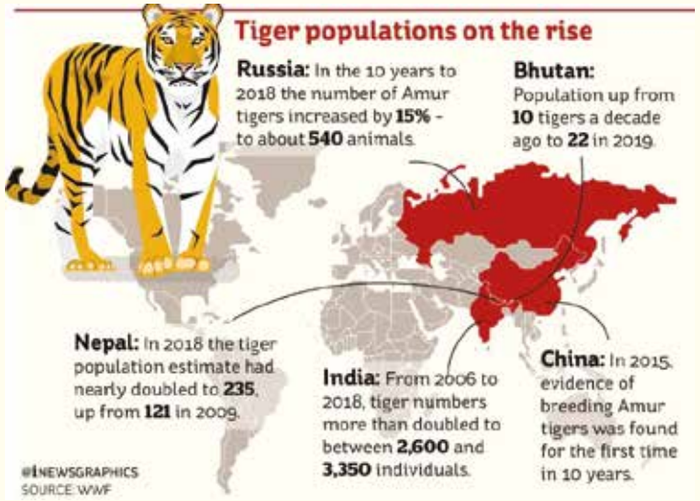
Nirmalya Chakraborty

ACROSS TIGER RANGES

CONSERVATION, MANAGEMENT AND POLICY RECOMMENDATION

Lim Yap, M., Sharma, M., Long, B., et al. (2020). How Effective Are Tiger Conservation. Conservation, 26(1), 115-127.

ABSTRACT



A global pledge to double wild Tiger populations by 2022 has focused attention on the need for effective conservation management. Conservation Assured | Tiger Standards (CA|TS) was established to identify good management standards for Tigers and promote these within Tiger conservation areas (TCAs). The study reported here assessed TCA management against a simplified version of CA|TS to uncover potential shortfalls in management and provide recommendations for future practices. From 11 Tiger range countries (TRCs), 111 TCAs were surveyed on their implementation of 40 strategic Tiger management activities, making it the largest Tiger management study to date. The study found that over a third of TCAs have major management deficiencies, threatening the survival of wild Tigers, biodiversity and natural resources. These deficiencies are especially prominent in South East Asian countries compared to other TRCs. Non-South East Asian countries had a significantly higher percentage of TCAs that had fully implemented the activities outlined in the survey. The lowest scoring elements of management, excluding tourism since that did not apply to all TCAs, were infrastructure, equipment and facilities, protection, and community relations. Recommendations include increased government funding, capacity building, and the implementation of CA|TS to secure the future of wild Tigers.

VIETNAM

CONSERVATION, MANAGEMENT AND POLICY RECOMMENDATION

Coals, P., Moorhouse, T. P., D'Cruze, N. C., Macdonald, D. W., and Loveridge, A. J. (2020). Preferences for lion and tiger bone wines amongst the urban public in China and Vietnam. Journal for Nature Conservation, 57, 125874. *https://doi.org/10.1016/j.jnc.2020.125874*

ABSTRACT

A controversial, multifaceted debate surrounds the trade in commercially captive-bred (farmed) lion skeletons. A prominent topic relates to relative preferences for tiger and lion bone in Asian consumer countries. To contribute preliminary information on this subject we conducted the first quantitative study to assess the consumer preferences of the urban public in China and Vietnam for lion versus tiger and wild versus farmed bone wine products. Using an online questionnaire we ranked respondents' stated preference for wild tiger, farmed tiger, wild lion, and farmed lion bone, and tested for the effect of demographic and attitudinal variables on product preferences. Our findings indicate that in both China and Vietnam tiger bone wine is greatly preferred over lion bone wine, and that respondents showed high levels of fidelity to their choice of farmed or wild designation across species. We emphasise the real-world complexity of lion and tiger bone product interactions and highlight opportunities for further in-depth study.

Illegal Trade

Davis, E. O., Willemsen, M., Dang, V., O'Connor, D., and Glikman, J. A. (2020). An updated analysis of the consumption of tiger products in urban Vietnam. Global Ecology and Conservation, 22, e00960. *https://doi.org/10.1016/j.gecco.2020.e00960*

ABSTRACT

Tigers are indisputably in danger of extinction due to habitat loss and demand for their parts. Tigers are extirpated in the wild from every country bar one in mainland East and Southeast Asia. Although consumption of tiger products is known to be established in China, less is known about demand for tiger products in Southeast Asia. In this study, we investigate tiger product demand in Vietnam, a major illegal wildlife consumer country. There has been little research into consumption, in particular the level of use, the products being consumed, variation in use of products between areas, and the motivations of consuming tiger products. Through a quantitative survey of 1120 individuals, we show that use of tiger products could be as high as ~11% of the sample in both urban centers of Vietnam, Hanoi and Ho Chi Minh City. Tiger bone glue is the predominant product used, for medicinal purposes. In Hanoi, it is generally purchased by the individual for self-use, while in Ho Chi Minh City it is generally purchased as a gift. In both cities, individuals were generally highly satisfied with the product, indicating entrenched belief in efficacy among consumers. Ultimately, our results show that tiger product use is relatively pervasive. We suggest that conservation organizations should focus on behavior change campaigns that are informed by the results here, and that are specific to each area and to the specific use of tiger product glue for medicine. By reducing demand, beleaguered tiger populations will have a greater chance of stabilization and eventual growth.

Nilanjan Chatterjee

Dhritiman Mukherjee

BANGLADESH

GENETICS

Alam, M., Rahaman, M. A., Begum, R. A., and Shahjahan, R. M. (2021). Non-invasive DNA extraction for molecular identification of Royal Bengal tiger Panthera tigris tigris. Dhaka University Journal of Biological Sciences, 30(2), 325-330.
http://dx.doi.org/10.3329/dujbs.v30i2.54657

ABSTRACT

The flagship animal species of Sundarbans, the Royal Bengal tiger (Panthera tigris tigris) is under threat of extinction. Its natural population is declining day by day. So, to avoid killing and harming the animal, the use of non-invasive samples such as scat, hair, or scent is preferred for DNA extraction and subsequent genotyping of tiger species. DNA has been extracted from scat samples of the Bengal tiger in the present study, and a fragment of the cytochrome b gene has been sequenced after PCR with species-specific primers. DNA has been extracted manually using a previously described methodology with slight modifications. The size of the PCR product and sequence of cytochrome b gene indicates that tiger DNA is successfully extracted from scat samples using tigerspecific primers. Thus, presence of tiger DNA can be detected by using this method just by the PCR product size in the gel. This is the first report of a partial sequence of mitochondrial cytochrome b gene of P. t. tigris from Bangladesh.

ZOOLOGY AND ANIMAL WELFARE

Hossain, M. N., Dey, A. R., Begum, N., and Farjan, T. (2021). Parasitic infection in captive wild mammals and birds in Bangabandhu Sheikh Mujib Safari Park, Cox's Bazar, Bangladesh. Journal of Threatened Taxa, 13(3), 17889-17894.
http://dx.doi.org/10.11609/jott.5682.13.3.17889-17894

ABSTRACT

We investigated the infection rate of gastrointestinal (GI) parasite eggs and premature stages from different wild animals and birds in Bangabandhu Sheikh Mujib Safari Park, Dulahazra, Cox's Bazar. A total of 56 fecal samples were collected from 24 species during July to November 2012 using modified Stoll's ova dilution technique. Coprology analysis revealed that the overall rate of parasitic infection was 78.6%, of which 51.8% were helminths and 35.7% protozoa. The identified parasites were Paramphistomum spp. (7.1%), Fasciola spp. (5.4%), strongyles

(26.8%), Ascaris spp. (3.6%), Strongyloides spp. (7.1%), Dictyocaulus spp. (5.4%), Trichuris spp. (3.6%), Capillaria spp. (5.4%), Heterakis spp. (3.6%), and Balantidium coli (35.7%). Mixed infection (21.4%) was observed in nine animals, including co-infection with Balantidium coli and strongyles in Tiger Panthera tigris, Sambar Deer Rusa unicolor and Pig-tailed Macaque Macaca nemestrina, Strongyloides spp., Trichuris spp. and larvae of Dictyocaulus spp. in Capped Langur Trachypithecus pileatus, Balantidium coli and Capillaria spp. in Clouded Leopard Neofelis nebulosa, Fasciola spp. and Balantidium coli in Spotted Deer Axis axis, Ascaris spp. and strongyles in African Elephant Loxodonta africana, Strongyloides spp. and Heterakis spp. in Peafowl Pavo cristatus and Heterakis spp. and strongyles coinfection in Great Pied Hornbill Buceros bicornis. It is concluded that GI parasites were prevalent in this safari park. Further epidemiological investigation is necessary for controlling parasitic infection.

Manoj Dholakia

BHUTAN

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATIONS

Thinley, P., Rajaratnam, R., Morreale, S. J., and Lassoie, J. P. (2021). Assessing the adequacy of a protected area network in conserving a wide-ranging apex predator: The case for tiger (Panthera tigris) conservation in Bhutan. Conservation Science and Practice, 3, e318. *https://doi.org/10.1111/csp2.318*

ABSTRACT

Protected area networks (PAN) are essential for conserving wide-ranging apex predators but their adequacy in species protection has rarely been assessed. Here, we assess the adequacy of Bhutan's PAN in conserving and providing connectivity to the endangered tiger (Panthera tigris). We determine the current extent of tiger habitat, predict new suitable habitat, identify potential corridors, and empirically estimate the range of tiger numbers that Bhutan can spatially support. We use two spatial models with different approaches to ascertain current tiger distribution and predict new suitable tiger areas: (a) an expert model based on tiger ecology and (b) an observation model from observed tiger distribution. The expert model identified more suitable tiger areas (32,887 km^2) over the observation model (29,962 km^2), with the PAN encompassing 46% and 45% of predicted suitable areas, respectively. Vast suitable tiger habitat remains unprotected. Based on our estimates of total suitable habitats, Bhutan can spatially support 138–151 tigers compared to the current estimate of 103, thereby precluding a doubling in tiger numbers. To ensure adequate protection of tigers in Bhutan, we recommend readjusting and/or expanding existing PAN boundaries, including the designation of new corridors, protecting habitats, and conserving prey populations.

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Letro, L., Fischer, K., Duba, D., and Tandin, T. (2021). Occupancy patterns of prey species in a biological corridor and inferences for tiger population connectivity between national parks in Bhutan. Oryx, 56(3), 421-428. *https://doi.org/10.1017/s0030605320000976*

ABSTRACT

Site occupancy models, accounting for imperfect detection and the influence of anthropogenic and ecological covariates, can indicate the status of species populations. They may thus be useful for exploring the suitability of landscapes such as biological corridors, to ensure

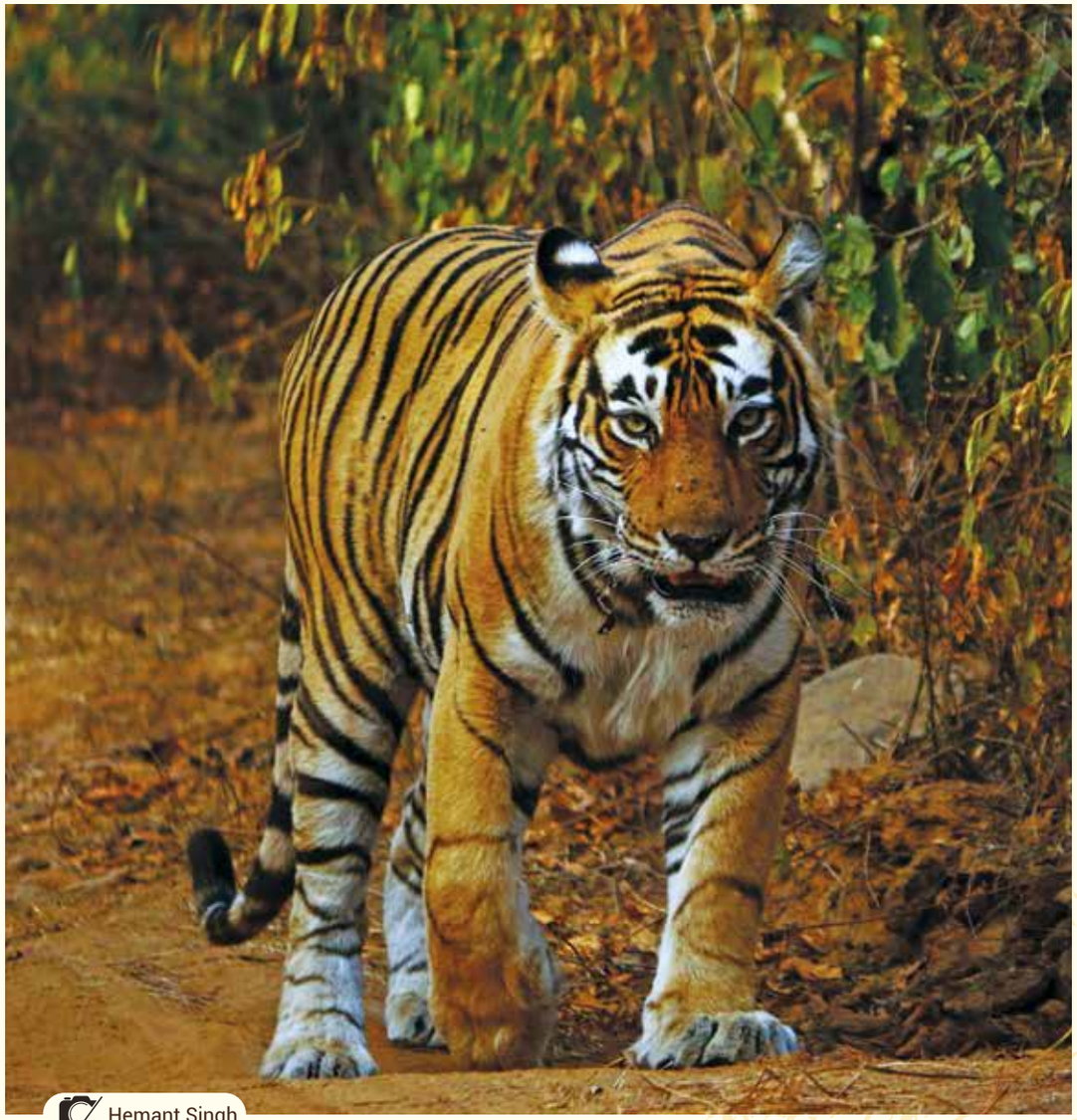
population dispersal and connectivity. Using occupancy probability models of its principal prey species, we make inferences on landscape connectivity for the movement of the tiger Panthera tigris between protected areas in Bhutan. We used camera-trap data to assess the probability of site occupancy (Ψ) of the sambar Rusa unicolor, wild boar Sus scrofa and barking deer Muntiacus muntjak in biological corridor no. 8, which connects two national parks in central Bhutan. At least one prey species was recorded at 17 out of 26 trapping locations. The probability of site occupancy was highest for the barking deer (Ψ = 0.52 ± SE 0.09) followed by sambar (Ψ = 0.49 ± SE 0.09) and wild boar (Ψ = 0.45 ± SE 0.07). All three species had higher occupancy probability at lower altitudes. Sambar occupancy was greater farther from settlements and on steeper and/or south-facing slopes. Barking deer also had higher occupancy on south-facing slopes, and wild boar occurred mainly close to rivers. Our findings suggest that this biological corridor could facilitate dispersal of tigers. Protecting prey species, and minimizing anthropogenic disturbance and habitat fragmentation, are vital for tiger dispersal and thus functional connectivity amongst populations in this area.

ZOOLOGY AND ANIMAL WELFARE

Phuentshok, Y., Choden, K., Alvarez Rojas, C. A., Deplazes, P., Wangdi, S., Gyeltshen, K., Rinzin, K., Thapa, N. K., Tenzinla, T., Dorjee, D., Valitutto, M. T., Gilbert, M., Siriaroonrat, B., Jairak, W., Piewbang, C., Sharma, P. M., Dema, T., and Gurung, R. B. (2021). Cerebral cysticercosis in a wild Bengal tiger (Panthera tigris tigris) in Bhutan: A first report in non-domestic felids. International journal for parasitology. Parasites and wildlife, 14, 150-156.
https://doi.org/10.1016/j.ijppaw.2021.02.003

ABSTRACT

The endangered Bengal tiger (Panthera tigris tigris) is a keystone species playing an essential role in ecology as well as in the social and spiritual lives of the Himalayan people. The latest estimate of the Bengal tiger population in Bhutan accounts for 103 individuals. Infectious organisms, including zoonotic parasites causing high burden in human health, have received little attention as a cause of mortality in tigers. Taeniosis/cysticercosis, caused by the cestode Taenia solium, is considered one of the major neglected tropical diseases in Southeast Asia. We present here a case of neurocysticercosis in a Bengal tiger showing advanced neurological disease outside Thimphu, the capital city of Bhutan. After palliative care, the animal died, and necropsy revealed multiple small cysts in the brain. Here we show the presence of two genetic variants of T. solium in the parasite material collected based on PCR and sequencing of the complete cox1 and cytB genes. The sequences form a discrete branch within the Asia plus Madagascar cluster of the parasite. On other hand, tests for feline morbillivirus, feline calicivirus, canine distemper virus, Nipah, rabies, Japanese encephalitis, feline leukaemia and feline immunodeficiency virus were negative. In contrast, PCR for feline herpesvirus was positive and a latex agglutination test revealed an elevated antibody titer against Toxoplasma gondii (titer 1:256). The molecular examination of taeniid eggs isolated from the tiger faeces produced sequences for which the highest homology in GenBank is between 92% and 94% with T. regis and T. hydatigena. This fatal case of T. solium neurocysticercosis, a disease previously unrecorded in tigers or other non-domestic felids, demonstrates an anthropogenically driven transmission of a deadly pathogen which could become a serious threat to the tiger population.



Hemant Singh

BORNEO

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Sherani, S. (2021). Short notes on a second tiger (Panthera tigris) from Late Pleistocene Borneo. Historical Biology, 33(4), 463-467. DOI: 10.1080/08912963.2019.1625348.

ABSTRACT

The tiger (Panthera tigris) has an archaic past on the Malay Archipelago. Despite such, the tiger is poorly recorded on Borneo, with just a single partial metacarpal being previously reported. This study presents the first mandibular remains and just the second fossil tiger from Borneo. The specimen is dated to MIS 2. It is morphologically most like southern subspecies of tiger but much larger than any extant form. The fossil record of the Bornean tiger indicates the region maintained a population of tigers throughout at least MIS 2 to some portion of MIS 1. A mixture of ecological and anthropological factors is likely the cause of the disappearance of the Bornean tiger.

Manoj Dholakia

CHINA

ZOOLOGY AND ANIMAL WELFARE

Chiu, H.-C., Fan, K., Sun, X., Lin, K., Chen, T., Yang, F., Qiu, Y., Wei, D., and Huang, C. (2021). Detection and molecular characterisation of intestinal parasites in the South China tiger (Panthera tigris amoyensis [Hilzheimer]). Folia Parasitologica, 68.
http://dx.doi.org/10.14411/fp.2021.029

ABSTRACT

Parasitic infections of the South China tigers in the Meihua Mountains have not been explored previously. Faeces of 22 South China tigers from the China Tiger Park in the Meihua Mountains were examined. Eggs of ascaridoid nematodes and oocysts of coccidia were detected by Mini-FLOTAC assay. Morphological observation and molecular characterisation of the oocysts were carried out. The prevalence of Toxascaris leonina (von Linstow, 1902) was 18% (4/22), and the highest egg per gram (EPG) count in the faeces was 27,150. The prevalence of Cystoisospora sp. was 45% (1 0/22) and the highest oocysts per gram (OPG) in the faeces was 6,000. In addition, we found one ascaridoid nematode in the South China tiger's faeces and was molecularly and morphologically identified as T. leonina. The oocysts in the faeces were sporulated in vitro and identified as Cystoisospora sp. Amplification of full-length internal transcribed spacers (ITS) resulted in sequences 1,622 bp long. Using the sequences, Cystoisospora sp. of the South China tiger was closest to Isospora belli (Wenyon, 1923) and Cystoisospora suis (Biester, 1934).

Liu, E., Ma, L., Huang, S., You, D., Guo, L., Xu, H., Liu, D., Chai, H., and Wang, Y. (2021). The first feline immunodeficiency virus in Siberian tigers (Panthera Tigris Altaica) from China. Archives of Virology. *http://dx.doi.org/10.21203/rs.3.rs-618834/v1*

ABSTRACT

Feline immunodeficiency virus (FIV) naturally infects more than 20 kinds of felines and poses a serious threat to their health, but there has been little research on FIV in tigers. In this study, 320 captive Siberian tigers (225 from Harbin, 55 from Hailin, and 40 from Shenyang) were tested for FIV by nested PCR, and three Siberian tigers from Hailin were FIV positive (5.45%). From these three animals, FIV gene fragments, gag-p26 (444 nt) from samples HD094 and HD1786 and pol-RT (576 nt) and pol-RNase (730 nt) from sample HD631, were sequenced and found to share more than 99% sequence identity with FIV subtype A from domestic cats. This is the first time FIV has been detected in Siberian tigers in China.

Mu, M., Zhao, H., Wang, Y., Guo, M., Nie, X., Liu, Y., and Xing, M. (2021). Interferon-beta, interferon-gamma and their fusion interferon of Siberian tigers (Panthera tigris altaica) in China are involved in positive-feedback regulation of interferon production. Developmental and Comparative Immunology, 125, 104211. *http://dx.doi.org/10.1016/j.dci.2021.104211*

ABSTRACT

As a group of cytokines, interferons are the first line of defense in the antiviral immunity. In this study, Siberian tiger IFN-β (PtIFN-β) and IFN-γ (PtIFN-γ) were successfully amplified, and the two were fused (PtIFN-γ) by overlap extension polymerase chain reaction (SOE-PCR). Bioinformatics analysis disclosed that PtIFN-β and PtIFN-γ have species-specificity and conservation in the course of evolution. After being expressed in prokaryotes, the antiviral activities and physicochemical properties of PtIFN-β, PtIFN-γ and PtIFNβ-γ were analyzed. In Feline kidney cells (F81), PtIFNβ-γ showed more active antiviral activity than PtIFN-β and PtIFN-γ, which has more stable physicochemical properties (acid and alkali resistance, high temperature resistance). In addition, PtIFN-β, PtIFN-γ and PtIFN-γ activated the JAK-STAT pathway and induced the transcription and expression of interferon-stimulated genes (ISGs). Janus kinase (JAK) 1 inhibitor inhibited ISGs expression induced by PtIFN-β, PtIFN-γ and PtIFN-γ. Overall, this research clarified that PtIFN-β, PtIFN-γ and PtIFNβ-γ have the ability to inhibit viral replication and send signals through the JAK-STAT pathway. These findings may facilitate further study on the role of PtIFN in the antiviral immune response, and help to develop approaches for the prophylactic and therapeutic of viral diseases based on fusion interferon.

Wang, Q., Shi, C., Liu, D., and Jiang, G. (2021). Estimation of body weight in captive Amur tigers (Panthera tigris altaica). Integrative Zoology, 17(6), 1106-1120. *http://dx.doi.org/10.1111/1749-4877.12612*

ABSTRACT

So far, there has been no safe and convenient method to weigh the large fierce animals, like Amur tigers. To address this problem, we built models to predict the body weight of Amur tigers based on the fact that body weight is proportional to body measurements or age. Using the method of body measurements, we extracted the body measurements from four different kinds of the lateral body image of tigers, i.e., total lateral image, central lateral image, ellipse fitting image and rectangle fitting image, and then we respectively used artificial neural network (ANN) and power regression model to analyze the predictive relationships between body weight and body measurements. Our results demonstrated that, among all ANN models, the model built with rectangle fitting image had the smallest mean square error. Comparatively, we screened power regression models which had the smallest Akakai information criteria (AIC). In addition, using the method of age, we fitted nonlinear regression models for the relationship between body weight and age and found that, for male tigers, logistic model had the smallest AIC. For female tigers, Gompertz model had the smallest AIC. Consequently, this study could be applied to estimate body weight of captive, or even wild, Amur tigers safely and conveniently, helping to monitor individual health and growth of the Amur tiger populations.

Yang, D., Wang, S., Sun, E., Chen, Y., Hua, L., Zhou, R., Chen, H., Peng, Z., and Wu, B. (2021). A temperate Siphoviridae bacteriophage isolate from Siberian tiger enhances the virulence of Methicillin-resistant Staphylococcus aureus through distinct mechanisms. Virulence, 13(1), 137–148. *http://dx.doi.org/10.1101/2021.05.03.442543*

ABSTRACT

The emergence and worldwide spread of Methicillin-resistant Staphylococcus aureus (MRSA) pose a threat to human health. While bacteriophages are recognized as an effective alternative to treat infections caused by drug resistant pathogens, some bacteriophages in particular the temperate bacteriophage may also influence the virulence of the host bacteria in distinct ways. In this study, we isolated a bacteriophage vB_Saus_PHB21 from an epidermal sample of Siberian tiger (Panthera tigris altaica) using an MRSA strain SA14 as the indicator. Our following laboratory tests and whole genome sequencing analyses revealed that vB_Saus_PHB21 was a temperate bacteriophage belonging to the Siphoviridae family, and this bacteriophage did not contain any virulence genes. However, the integration of PHB21 genome into the host MRSA increased the bacterial capacities of cell adhesion, anti-phagocytosis, and biofilm formation. Challenge of the lysogenic strain (SA14+) caused severe mortalities in both Galleria mellonella and mouse models. Mice challenged with SA14+ showed more serious organ lesions and produced higher inflammatory cytokines (IL-8, IFN-γ and TNF-α) compared to those challenged with SA14. In mechanism, we found the integration of PHB21 genome caused the upregulated expression of many genes encoding products involved in bacterial biofilm formation, adherence to host cells, antiphagocytosis, and virulence. This study may provide novel knowledge of “bacteria-phageinteractions” in MRSA.

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Yuan, Y., Yin, Y., and Liu, Q. (2021). Inbreeding depression and population viability analysis of the South China tigers (Panthera tigris amoyensis) in captivity. Mammalian Biology, 101(6), 1-7. *https://link.springer.com/article/10.1007/s42991-021-00113-6*

ABSTRACT

The South China tiger (SCT) is close to extinction in the wild and the captive population may be the only hope of saving this species. Based on the international studbook of the SCT from 1956 to 2019, the life history and population parameters were summarized, and lethal equivalents (B) were estimated. Population viability analysis (PVA) was carried out to simulate the population dynamics and the effects of key factors influencing population dynamics were assessed on the basis of sensitivity analysis, including lethal equivalent, sex ratio, percentage of females breeding and percentage of males breeding. The average B value for the captive SCT population was estimated to be 4.24 at the population level. The captive population of SCT is currently growing up, with a positive growth rate of 0.093 (SD = 0.088) and a probability of extinction of 1% within the next 100 years. The current SCT population is sensitive to lethal equivalents (S = 2.30) and the percentage of females breeding (S = 1.94). We suggest a feasible breeding plan that can practically reduce the effect of inbreeding, and better husbandry practices to improve the percentage of females breeding.

Zhu, Y., Han, Z., Wang, H., Liu, C., Si, H., and Xu, C. (2021). Adaptation of the gut microbiota of Amur tigers to a special diet. Current Microbiology, 78(4), 1628-1635. *http://dx.doi.org/10.1007/s00284-021-02399-8*

ABSTRACT

The microorganisms inhabiting the gastrointestinal tract play important roles in many host physiological processes, including the absorption and metabolism of nutrients and immune function. The Amur tiger (Panthera tigris altaica) is listed by the International Union for the Conservation of Nature (IUCN) as a threatened species. Efforts are underway to breed Amur tigers under artificial settings to preserve this rare species. To maximize the imitation of the diet that this species consumes in the wild, the diet in the present study was composed of a variety of raw meats and was administered with regular fasting. In view of the important roles that the microbiota play in the host, in the present study, the microbiota of Amur tigers at three different ages were investigated. The results showed that the microbial diversity and richness decreased with age. Principal coordinate analysis showed significant differences among the three age groups. Linear discriminant analysis (LDA) of effect size (LEfSe) demonstrated the enrichment of the genus unclassified_f__Ruminococcaceae, genus Coprococcus_1, genus Ruminococcus__gauvreauii_group, family unclassified_o__Clostridiales and genus unclassified_o__Clostridiales in the JB group (1- year old) and the enrichment of the genus Catenisphaera in the AB group (over 4-year old). The results of the present study demonstrated the adaptation of the microbiota in captive Amur tigers to a diet similar to the one they consume in the wild. Furthermore, these results may reflect the microbiota of wild Amur tigers to a certain extent.

MONITORING AND ASSESSMENT

Jin, Y., Kong, W., Yan, H., Bao, G., Liu, T., Ma, Q., Li, X., Zou, H., and Zhang, M. (2021). Multi-Scale Spatial Prediction of Wild Boar Damage Risk in Hunchun: A Key Tiger Range in China. Animals, 11(4), 1012-. *http://dx.doi.org/10.3390/ani11041012*

ABSTRACT

Hunchun, a typical area suffering wild boar (Sus scrofa) damage, is an important region for the Siberian Tiger (Panthera tigris) in China. By incorporating the maximum entropy model with 22 variables in the home range scale (12 variables) and in the feeding site scale (10 variables), we predicted wild boar damage risks in this area of China and analyzed how spatial factors influence damage risk. Damage risk was found to be high in areas close to the forest edge, areas with a higher forest cover and lower to medium deciduous forest proportion, low road density, and a medium river density and farmland proportion. The proportion of farmland which was identified as being in the high damage risk zone was 23.55%, of which 38.68% was within the habitat area of the Siberian Tiger. Finally, we propose wild boar damage prevention based on different management goals.

Ning, Y., Roberts, N. J., Qi, J., Peng, Z., Long, Z., Zhou, S., Gu, J., Hou, Z., Yang, E., Ren, Y., Lang, J., Liang, Z., Zhang, M., Ma, J., and Jiang, G. (2021). Inbreeding status and implications for Amur tigers. Animal Conservation, 25(4), 521-531. *http://dx.doi.org/10.1111/acv.12761*

ABSTRACT

Inbreeding more likely occurs in small, isolated and endangered populations, and may influence the sustainable survival of a population. As the Amur tiger Panthera tigris altaica population in China experienced a severe decline in the 1990s, the recovering population may be prone to inbreeding and its potential impacts on population health. However, the inbreeding status has not been evaluated and relationships with health remain poorly understood in wild animals. Based on the genetic samples collected from the main Amur tiger habitats in China, this study

analyzed the population inbreeding level, major histocompatibility complex polymorphism, parasitic infections and gut microbial structures and functions, and then explored the influence of inbreeding on these traits. Our results indicated that more than 50% of individual relationships were in cousin or half sibs, and 22.73% of individuals had moderate or high inbreeding coefficients. There was a significant positive correlation between the inbreeding level of an individual and the Toxocara cati parasitic load. Gut microbiota community structure and function were also impacted by inbreeding intensity. In conclusion, results indicate that the Amur tiger population in China has reached a moderate level of inbreeding and that there are direct interactions between inbreeding intensity and parasitic load and gut microbiota. This study thus provides an early warning on the Amur tiger population health and should prompt the construction of national and international ecological corridors and/or the re-introduction of new individuals to relieve the evident inbreeding pressure.

Perez, F., Piao, Z., and Liu, X. (2021). Habitat suitability for a community of Amur tigers (Panthera tigris altaica) and their prey in Changbaishan. Environmental Science and Pollution Research International, 29(8), 1-12. *http://dx.doi.org/10.1007/s11356-021-16469-8*

ABSTRACT

The Changbaishan reserve and the forests around it are one of the priority areas for Amur tiger (Panthera tigris altaica) recovery in northeastern China. Previous habitat suitability analyses only took the ecological requirements of tigers into consideration, so this study aims to determine habitat suitability for a tiger-prey community in the region, by analysing ungulate prey availability and habitat suitability for both predator and prey. Three prey species were found, using the snow tacking method: red deer (Cervus canadensis xanthopygus), wild boar (Sus scrofa), and roe deer (Capreolus pygargus). Habitat suitability was evaluated for tigers, red deer, and wild boar, using a multi-criteria evaluation (MCE) process. MCE results showed that (1) habitat suitability is generally low outside the reserve for all three species; (2) suitability values were the lowest for tigers due to high intensity of human impact in the area, with suitable habitat restricted to the centre of the reserve; and (3) red deer and wild boar would find pockets of suitable habitat outside the reserve. A combination of low forest quality and high human impact intensity imposes significant environmental pressure to those ungulates. To recover tiger population in Changbaishan, forest quality and human impacts should be properly managed, which should increase prey availability.

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATION

Illegal Trade

Song, Z., Wang, Q., Miao, Z., Zhang, W., and Zhou, X. (2021). The dissemination of relevant information on wildlife utilization and its connection with the illegal trade in wildlife. Journal of Forestry Research, 33(1), 357-367. *http://dx.doi.org/10.1007/s11676-021-01306-y*

ABSTRACT

We analyzed the generation and dissemination of relevant information on wildlife utilization based on the African bush elephant (Loxodonta africana Blumenbach.), the tiger (Panthera tigris L.) and the totoaba, a species of marine fish, (Totoaba macdonaldi Gilbert) as examples, whose populations are more threatened by the illegal wildlife trade. We compared the illegal trade in wildlife with related information in order to find possible associations, searched for relevant information on major international websites to summarize similarities in information production and dissemination, and used a “Zhiwei” dissemination analysis platform to analyze the dissemination of information circulated at Microblog. The results show that the most influential information related to the trade in wildlife is mainly generated from news media websites and new self-media platforms, usually from non-governmental organizations concerned with wildlife protection. The main factors that affect the depth and breadth of disseminating relevant information on wildlife utilization include the participation of relatively influential opinion leaders, the verification ratio of forwarding users, the number of followers, and affective identification. Misleading information can stimulate and promote poaching and smuggling, regardless of their real market demand or their products. Therefore, all links in the course of information dissemination should be carefully examined in order to purify the information environment and reduce adverse effects of misleading information on wildlife protection.

GENETICS

Li, H., Liu, Y., Wang, C., Li, Y., Chen, Y., Wang, L., Zhou, X., and Xie, Y. (2021). The complete mitogenome of Toxascaris leonina from the Siberian tiger (Panthera tigris altaica). Mitochondrial DNA. Part B, Resources, 6(4), 1416-1418. *http://dx.doi.org/10.1080/23802359.2021.1911713*

ABSTRACT

Toxascaris leonina is a polyxenical parasite and commonly found in canids and felids. In this study, we used the Illumina high throughput sequencing and assembly to determine the

complete mitogenome of a representative of this parasite from the Siberian tiger (Panthera tigris altaica). The genome was 14,248 bp in size and encoded 12 protein-coding genes, 22 transfer RNAs, and two ribosomal RNAs. Phylogeny showed that two canid (dog)-originated T. leonina were phylogenetically distinct from two felid-originated T. leonina (tiger isolate and cheetah isolate), suggesting at least two distinct subclades of T. leonina infecting these hosts and supporting once again that T. leonina represents a species complex. Furthermore, four isolates of T. leonina grouped together and were more closely related to other species from the family Ascarididae than species of families Toxocaridae, Anisakidae and Ascaridiidae, demonstrating phylogenetic stability of these paraphyletic groups characterized in this study. These cumulative mitochondrial DNA data provide a better understanding of phylogenetic relationships of this polyxenical and zoonotic roundworm species.

Sun, Y., Yao, J., Zhang, M., Chen, T., Xu, W., Wenyuan, F., Wu, Q., Yan, L., Chen, X., Zhu, Y., Zhang, X., Liu, L., Chen, D., Wang, Z., You, Z., Zhang, X., Liu, Y., Lin, K., and Lin, W. (2021). Colonization and development of the fecal microflora of South China Tiger cubs (Panthera tigris amoyensis) by sequencing of the 16S rRNA gene. Microbial Physiology, 32(2), 18-29. *http://dx.doi.org/10.1159/000518395*.

ABSTRACT

Postnatal colonization and development of the gut microbiota is linked to health and growth. A comprehensive understanding of the postnatal compositional changes and development of the microbial community is helpful to understand the gut health and improve the survival rate of South China tiger cubs (Panthera tigris amoyensis). Fecal samples from three tiger cubs were collected on the day of birth in 2018 (June 17–21 [G0], July 18 [G1], July 31 [G2], and August 7 [G3]). The 16S rRNA genes of the fecal microflora were sequenced. Results showed that 38 phyla, 58 classes, 134 orders, 272 families, and 636 genera of bacteria from 3,059 operational taxonomic units were identified from 12 fecal samples. The diversity and abundance of species of group G0 were significantly higher ($p < 0.05$ or 0.01) than those of groups G2 and G3. The predominant phylum was Proteobacteria in groups G0 and G1 (38.85% and 48%, respectively) and Firmicutes in groups G2 and G3 (71.42% and 75.29%, respectively). At the phylum level, the abundance of Deinococcus-Thermus was significantly decreased in groups G1, G2, and G3 as compared to group G0 ($p < 0.05$), while that of Firmicutes was significantly increased in groups G2 and G3 ($p < 0.05$). At the genus level, the abundance of Faecalibacterium , Ralstonia , and unidentified Rickettsiales was significantly decreased in groups G1, G2, and G3 as compared with group G0 ($p < 0.05$), while that of Pseudomonas was significantly decreased in groups G2 and G3 ($p < 0.05$). The composition and structure of fecal microbiota of South China tiger cubs changed after birth.

Wang, C., Wu, D.-D., Yuan, Y.-H., Yao, M.-C., Han, J.-L., Wu, Y.-J., Shan, F., Li, W.-P., Zhai, J.-Q., Huang, M., Peng, S.-M., Cai, Q.-H., Yu, J.-Y., Liu, Z.-Y., Li, L.-X., Teng, M.-S., Huang, W., Zhou, J.-Y., Zhang, C., Chen, W., and Tu, X.-L. (2021). Population genomic analysis provides strong evidence of the past success and future strategies of South China tiger breeding. BMC Biology, 21(1), 64. *https://doi.org/10.1186/s12915-023-01552-y*. *http://dx.doi.org/10.21203/rs.3.rs-1157812/v1*

ABSTRACT

The South China tigers (Panthera tigris amoyensis) are extinct in the wild, but viable populations remain in breeding centers and zoos after 60 years of effective conservation efforts. At present, however, the existing genetic variation of these tigers remains unknown. In this study, we assembled a high-quality chromosome-level genome using long-read sequences and re-sequenced 29 high-depth genomes of the South China tigers. We identified two significantly differentiated genomic ancestries in the extant populations, which also harbored some rare genetic variants introgressed from other subspecies, suggesting limited but essential genetic diversity to sustain the South China tigers. The unique pattern of dual ancestry and the genomic resources generated in our study pay the way for a genomics-informed conservation, following the real-time monitoring and controlled exchange of all reproductive South China tigers.

Nilanjan Chatterjee

GLOBAL

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Armstrong, E. E., Khan, A., Taylor, R. W., Gouy, A., Greenbaum, G., Thiéry, A., Kang, J. T., Redondo, S. A., Prost, S., Barsh, G., Kaelin, C., Phalke, S., Chugani, A., Gilbert, M., Miquelle, D., Zachariah, A., Borthakur, U., Reddy, A., Louis, E., Ryder, O. A., Jhala, Y. V., Petrov, D., Excoffier, L., Hadly, E., and Ramakrishnan, U. (2021). Recent evolutionary history of tigers highlights contrasting roles of genetic drift and selection. Molecular Biology and Evolution, 38(6), 2366-2379. doi: 10.1093/molbev/msab032.

ABSTRACT

Species conservation can be improved by knowledge of evolutionary and genetic history. Tigers are among the most charismatic of endangered species and garner significant conservation attention. However, their evolutionary history and genomic variation remain poorly known, especially for Indian tigers. With 70% of the world's wild tigers living in India, such knowledge is critical. We re-sequenced 65 individual tiger genomes representing most extant subspecies with a specific focus on tigers from India. As suggested by earlier studies, we found strong genetic differentiation between the putative tiger subspecies. Despite high total genomic diversity in India, individual tigers host longer runs of homozygosity, potentially suggesting recent inbreeding or founding events, possibly due to small and fragmented protected areas. We suggest the impacts of ongoing connectivity loss on inbreeding and persistence of Indian tigers be closely monitored. Surprisingly, demographic models suggest recent divergence (within the last 20,000 years) between subspecies and strong population bottlenecks. Amur tiger genomes revealed the strongest signals of selection related to metabolic adaptation to cold, whereas Sumatran tigers show evidence of weak selection for genes involved in body size regulation. We recommend detailed investigation of local adaptation in Amur and Sumatran tigers prior to initiating genetic rescue.

Frank E. Zachos, C. J. Burgin, D. E. Wilson, R. A. Mittermeier, A. B. Rylands, T. E. Lacher, W. Sechrest. (2021). Illustrated Checklist of the Mammals of the World. Mammalian Biology, 101(1), 125-126. *http://dx.doi.org/10.1007/s42991-020-00088-w*.

ABSTRACT

A The Introduction, authored by Connor J. Burgin, Jane Widness, and Natham S. Uhpam (the latter two are not among the editors of the Checklist, even when the Introduction explains the structure of the Checklist) is informative and broad. It covers, among others, general aspects of mammalian systematics, species concepts, speciation, and nomenclature, as well as a summary of how species counts have changed over time and among different initiatives, a suprafamilial classification of mammals, and a family level mammal phylogeny (that misses some families recognized in the Checklist, such as Zenkerellidae and Sminthidae). If it were not for its last section “Using the Checklist,” the Introduction could easily be a stand-alone essay on general aspects of mammal diversity, and this is reinforced by the fact it has its own reference list. Because the Checklist is based on the HMW volumes that were published over a period of 11 years (2009 – 2019), it would have been useful to include a summary of how much current content and counts depart from those of the HMW series for each mammalian order.

After the Introduction comes the checklist. The three main lineages of mammals are presented in the traditional order, Prototheria, Metatheria, and Eutheria, although the higher taxonomic category used is order. Orders of Metatheria and Eutheria and families within orders are arranged phylogenetically. One inconsistency is that while in the checklist the order encompassing even-toed ungulates and cetaceans is recognized as Cetartiodactyla, this order level taxon is, in a scheme that we favor, labeled as Artiodactyla in the phylogenetic tree of the Introduction (figure 1, page 28). Genera within families or tribes, and species within each genus, are not presented alphabetically as is done in similar catalogs. The basis of the ordering is not presented. However, it seems that species were latitudinally arranged (from north to south) but several exceptions are to be found. The fact that genera and species are not alphabetically ordered presents some difficulty when one wants to look for a particular taxon, especially in species-rich genera with broad geographic distributions (e.g., Myotis, Sorex), or diverse suprageneric taxa.

The Accounts of the 6,554 listed species are short and include common names in English, French, German, and Spanish, scientific name, a brief taxonomic section including taxon authority and type locality, followed by a concise indication of the species distribution. Where subspecies are recognized, these are listed with indications of their distribution. The IUCN's conservation status up to 27 July 2020 is given for those species that have been evaluated. Also, each species in the Checklist is cross-referenced to the HMW volume and page where it appears.

The illustrations that accompany the text are impressive, realistic, and finely executed. This is especially true for some groups of medium-sized to large and charismatic mammals, as are carnivores and artiodactyls. In a few other groups, such as rodents and bats, figures are less realistic. There is heterogeneity among plates because multiple artists were involved that include: Toni Llobet, with Ilian Velikov, Lluís Sogorb, Faansie Peacock, Àlex Mascarell, Francesc Jutglar, Blanca Martí, Stephen D. Nash, and Jesús Rodríguez-Osorio. Illustrations are clearly among the highlights of the Checklist and one of the reasons why most people interested in mammals would enjoy the book. For several species, more than one illustration is provided, either

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to illustrate cases of sexual dimorphism (e.g., several cervids, odontocetes, and primates) or notable cases of geographic variation (e.g., the killer whale Orcinus orca). A scale is provided in each plate (or plate sections when animals illustrated in the same plate are considerably varied in size). In this sense it is nice to see the size of the small bat Craseonycteris thonglongyai, which is illustrated at real scale (Vol. 2, p. 117). Regarding illustrations, we suggest that the next edition redraw some species (e.g., colugos, hylobatids, pongins, and uakaris) that look unnatural, for example, hanging from tree branches that were not drawn.

A main departure from the nine volumes of the HMW is that the Checklist includes domestic species as well as those recently extinct. The inclusion of recently extinct species is reasonable, as some have been recorded decades after believing them to be extinct (e.g., Nesoryzomys swarthi from the Galápagos Islands). The inclusion also reminds us of the negative impact of some of our activities. However, the inclusion of domestic forms, even without illustrations, is questionable because this suggests that they represent distinct species as opposed to selected variants of wild species.

The Checklist does not list Homo sapiens and therefore the family Hominidae does not include a species of its type genus. The basis for this undesirable exclusion was not given in the Checklist. However, we note that our species was not included in the Primates volume of the HMW. There, it was left out given the impossibility of synthesizing all information available for H. sapiens into a short species account. In the Checklist this argument should not apply. We expect H. sapiens will be included in a future edition of the Checklist.

As usually happens with a large compilation, there were inconsistencies. For instance, not all genera erected in the past few years have explanatory notes as described in the Introduction (e.g., Cheracebus from 2015 has notes, while Paynomys from 2016 does not). In some cases, distributional ranges are partial. For example, the map for the skunk, Conepatus chinga, does not cover the distribution corresponding to C. humboldti, which here is not considered as a distinct species, but shows the range of C. chinga s.s. A few taxonomic treatments (e.g., to consider Abrawayaomys ruschii as a species with two subspecies) are considered questionable, while others (e.g., to treat Juliomys as an incertae sedis Sigmodontinae or Oryzomyialia and not as a Wiedomyini) are outdated. Overall, these occasional inconsistencies did not detract from the value of the work.

The intended readership is not stated in the Introduction and perhaps it should have been. This work may be too technical for the general public. However, the illustrations would be an easy entry point. At the same time, the brevity with which some aspects are covered is somewhat short for mammal taxonomists. For instance, common English names, which for most mammals are seldomly used, are more prominent than scientific names and appear first (above) in each

species entry. In addition, authorities of suprageneric taxa are not provided and synonyms are not given for genera. Taxonomic notes lack in-text citations, which makes it difficult to track the source. These details detract from the value of the work as a nomenclatorial and taxonomic reference. For taxonomists the Checklist therefore is not a substitute for Mammal Species of the World III (Wilson and Reader 2005) or other recent taxonomically centered works (e.g., Monadjem et al. 2015; Patton et al. 2015). As such, it seems the Checklist is more suited for the general reader interested in mammals than for mammalian systematists and taxonomists. Since the publication of the Checklist, several new mammal species have been formally described or raised from synonym lists, while others have been synonymized. For instance, in the issue of February 2021 of the Journal of Mammalogy, five species new to science were described. Furthermore, not all recently described new species correspond to small mammals; early this year a new species of whale was described (Rosel et al. 2021). These new descriptions remind us how quickly a work like this can become out of date and of the need to sustain other initiatives. In this regard, it is worth mentioning that the ASM Mammal Diversity Database (www.mammaldiversity.org) is intended to be regularly updated (and as to 19 April 2021, 6,533 species are listed).

We greatly appreciate the publication of the Checklist. It will engage the next generation of mammalogists and will allow lay people to marvel at the diversity of forms within our own class. In addition to its academic value, it is a pleasure to browse through this work. It reminds us of the wonder of nature, the value of Biodiversity, and of the lasting work of thousands of colleagues. Lastly, it affords the unrivaled sensation of reading a beautiful book.

Kokkonias e Castro, S. (2021). Eficácia de diferentes métodos de reprodução artificial em Panthera tigris altaica: Revisão Sistemática (Efficacy of different methods of artificial reproduction in Panthera tigris altaica: A systematic review), [Master's thesis], Universidade Estadual Paulista. *https://repositorio.unesp.br/handle/11449/210874*.

ABSTRACT

The Amur Tiger (Panthera tigris altaica) is one of six subspecies recognized by the International Union for Conservation of Nature (IUCN). Its population in the wild is estimated to be less than 400 individuals, with low genetic diversity. The intention of this systematic review was to verify the methods of artificial reproduction, which has been applied in this subspecies, as well as to consider their efficiency as a mechanism to assist in its conservation. With this approach, five English-language articles were selected, demonstrating the use of four assisted reproduction techniques, however there isn't a preferred artificial reproduction technique for this subspecies yet.

Tidière, M., Douay, G., Müller, P., Siberchicot, A., Sliwa, A., Whipple, M., and Douhard, M. (2021). Lifespan decreases with proportion of sons in males but not females of zoo-housed tigers and lemurs. Journal of Evolutionary Biology, 34(7), 1061-1070. *http://dx.doi.org/10.1111/jeb.13793*.

ABSTRACT

Several studies have shown higher costs of rearing sons than daughters in mammals where males are larger than females. These studies typically focus on females by examining how the offspring sex ratio during a single reproductive event affected mothers' subsequent reproduction or survival probability. Here, we examine relationships between offspring sex ratio during single or multiple reproductive events and several survival metrics in mothers and fathers, using data from zoo housed tigers (Panthera tigris) and ruffed lemurs (Varecia sp.). Our analyses failed to reveal an overall cost of reproduction or a higher cost of sons to mothers. In male ruffed lemurs, the proportion of sons produced during early life (before 10 years old) was negatively correlated with lifespan later in life. In tigers, males with a higher proportion of sons during their lifetime had shorter lifespans. One likely mechanism is the difference in testosterone levels between males: a high concentration of testosterone can increase the proportion of sons and compromise immune function. Our results suggest studies in wild populations should address the outstanding challenge of understanding consequences of sex allocation for males, and open an opportunity to predict lifespan in an applied conservation context.

Morphology

Siciliano-Martina, L., Light, J. E., and Lawing, A. M. (2021). Cranial morphology of captive mammals: A meta-analysis. Frontiers in Zoology, 18(1), 1-13. *http://dx.doi.org/10.1186/s12983-021-00386-0*.

ABSTRACT

Background Captive facilities such as zoos are uniquely instrumental in conservation efforts. To fulfill their potential as bastions for conservation, zoos must preserve captive populations as appropriate proxies for their wild conspecifics; doing so will help to promote successful reintroduction efforts. Morphological changes within captive populations may be detrimental to the fitness of individual animals because these changes can influence functionality; thus, it is imperative to understand the breadth and depth of morphological changes occurring in captive populations. Here, we conduct a meta-analysis of scientific literature reporting comparisons of cranial measures between captive and wild populations of mammals. We investigate the pervasiveness of cranial differences and whether cranial morphological changes are associated with ecological covariates specific to individual species, such as trophic level, dietary breadth, and home range size. Results Cranial measures of skull length, skull width, and the ratio of skull length-to-width differed significantly between many captive and wild populations of mammals reported in the literature. Roughly half of captive populations differed from wild populations in at least one cranial measure, although the degree of changes varied. Carnivorous species with a limited dietary breadth displayed the most consistent changes associated with skull widening. Species with a more generalized diet displayed less morphological changes in captivity. Conclusions Wild and captive populations of mammals differed in cranial morphology, but the nature and magnitude of their cranial differences varied considerably across taxa. Although changes in cranial morphology occur in captivity, specific changes cannot be generalized for all captive mammal populations. The nature of cranial changes in captivity may be specific to particular taxonomic groups; thus, it may be possible to establish expectations across smaller taxonomic units, or even disparate groups that utilize their cranial morphology in a similar way. Given that morphological changes occurring in captive environments like zoos have the potential to limit reintroduction success, our results call for a critical evaluation of current captive husbandry practices to prevent unnecessary morphological changes.

CONSERVATION, MANAGEMENT AND POLICY RECOMMENDATION

Li, J., and Hu, Q. (2021). Using culturomics and social media data to characterize wildlife consumption. Conservation Biology: The Journal of the Society for Conservation Biology, 35(2), 452-459. *https://doi.org/10.1111/cobi.13703*.

ABSTRACT

Wildlife provides food, medicine, clothing, and other necessities for humans, but overexploitation can disrupt the sustainability of wildlife resources and severely threaten global biodiversity. Understanding the characteristics of consumer behavior is helpful for wildlife managers and policy makers, but the traditional survey methods are laborious and time-consuming. In contrast, culturomics may more efficiently identify the features of wildlife consumption. As a case study of the culturomics approach, we examined tiger bone wine consumption in China based on social media and Baidu search engine data. Tiger bone wine is one of the most purchased tiger products; its consumption is closely related to tiger poaching, which greatly threatens wild tiger survival. We searched a popular social media website for the term “tiger bone wine” and focused on posts that were originally created from 1 January 2012 to 31 December 2018. We filtered and classified posts related to the purchase, sale, or consumption of tiger bone wine and extracted information on providers, consumption motivations, year of production, and place of origin of the tiger bone wines based on the texts and photos of these posts. We found 756 posts related to tiger bone wine consumption, 113 of which mentioned providers of

tiger bone wine, including friends (53%), elder relatives (37%), peer relatives (7%), and others (3%). Out of the 756 posts, 266 indicated the motivations of tiger bone wine consumption. Tiger bone wines were consumed as a tonic (34%), medicine (23%), game product (30%), and a symbol of wealth (28%). Some posts indicated ≥2 consumption motivations. These findings were consistent with the search queries from Baidu index. Such information could help develop targeted strategies for tiger conservation. The culturomics approach illustrated by our study is a rapid and cost-efficient way to characterize wildlife consumption.

Collins, C. K., McKeown, S., and O'Riordan, R. M. (2021). Does an Animal–Visitor Interactive Experience Drive Conservation Action? Journal of Zoological and Botanical Gardens, 2(3), 473-486. *https://doi.org/10.3390/jzbg2030034*.

ABSTRACT

Inspiring visitors to engage in conservation-related behaviour following a zoo visit is a primary objective for most zoos. Animal–visitor interactive (AVI) experiences are often central to this goal. Yet, these interactive experiences are insufficiently evaluated from both the visitors' and captive animals' perspectives. The current study took place at Fota Wildlife Park and involved the construction of an environmental enrichment device during an interactive visitor experience with Sumatran tigers (Panthera tigris sumatrae). It aimed to simultaneously encourage pro-conservation behaviour in visitors and promote animal welfare. Visitors (n = 51) completed a survey, observed the tigers' behaviour and made a pledge to help tigers in the wild after completion of the AVI. Tiger behaviour was simultaneously observed by a trained researcher using occurrence or non-occurrence sampling, which found no indication that tiger welfare was compromised during the activity and was likely enhanced by engaging with the enrichment. Additionally, visitors observed a range of tigers' behaviours. The results indicated that some visitors (8%) had continued with their pledge six weeks after the experience, and most visitors exhibited a high level of knowledge and a positive attitude towards tigers. The use of enrichment during AVIs may be a positive link between the visitor experience and animal welfare. These results can be used to guide AVIs in zoos which aim to connect people with nature and drive pro-conservation behaviour in visitors.

Rieder, E., Larson, L. R., 't Sas-Rolfes, M., and Kopainsky, B. (2021). Using Participatory System Dynamics Modeling to Address Complex Conservation Problems: Tiger Farming as a Case Study. Frontiers in Conservation Science, 2, 696615. *https://doi.org/10.3389/fcosc.2021.696615*.

ABSTRACT

Conservation practitioners routinely work within complex social-ecological systems to address threats facing biodiversity and to promote positive human-wildlife interactions. Inadequate understanding of the direct and indirect, short- and long-term consequences of decision making within these dynamic systems can lead to misdiagnosed problems and interventions with perverse outcomes, exacerbating conflict. Participatory system dynamics (SD) modeling is a process that encourages stakeholder engagement, synthesizes research and knowledge, increases trust and consensus and improves transdisciplinary collaboration to solve these complex types of problems. Tiger conservation exemplifies a set of interventions in a complex social-ecological system. Wild tigers remain severely threatened by various factors, including habitat constraints, human-wildlife conflict, and persistent consumer demand for their body parts. Opinions differ on whether commercial captive tiger facilities reduce or increase the threat from poaching for trade, resulting in policy conflict among diverse stakeholder groups. This paper explains how we are working with international conservation partners in a virtual environment to utilize a participatory SD modeling approach with the goal of better understanding and promoting coexistence of humans and wild tigers. We highlight a step-by-step process that others might use to apply participatory SD modeling to address similar conservation challenges, building trust and consensus among diverse partners to reduce conflict and improve the efficacy of conservation interventions.

Sheridan, K. M., and Kimball Brewitt, P. (2021). Assessing the efficacy of the Tiger Stamp: A policy tool approach. Journal of Environmental Studies and Sciences, 11(2), 227-233. *https://doi.org/10.1007/s13412-020-00661-2*.

ABSTRACT

International conservation presents a unique challenge for American conservation agencies, demanding unique policy tools. To encourage American citizens to support overseas conservation, the Fish and Wildlife Service, the United States Postal Service, and environmental non-governmental organizations collaborated to create the Save Vanishing Species Stamp, a semipostal stamp featuring a tiger. In doing this, these actors relied on the flagship species approach, wherein a charismatic species attracts attention and support for ecological protection. The "Tiger Stamp" has been on sale since 2011, but its effectiveness as a policy tool is uncertain. In this paper, we discuss the Tiger Stamp and analyze its effectiveness from several angles. The stamp's impact on species conservation is uncertain and its sales have been lower than those of past semipostal stamps, but this should be understood in the context of nationwide decline in traditional postal activities and the hortatory effect of the stamp beyond its economic effects. We conclude that the stamp is, on balance, a valuable policy tool, and should be continued.

Tidière, M., Müller, P., Sliwa, A., Siberchicot, A., and Douay, G. (2021). Sex-specific actuarial and reproductive senescence in zoo-housed tiger (Panthera tigris): The importance of sub-species for conservation. Zoo Biology, 40(4), 320-329. *https://doi.org/10.1002/zoo.21610*.

ABSTRACT

A fifth of all known species are currently classified as threatened in the wild: the rate of biodiversity loss is rapid, continuous, and mostly due to anthropogenic activities. To slow down this decline, the accurate estimation of demographic parameters for threatened species is critical. With this aim, zoo institutions play an important role, giving access to data on zoo-housed animals, which aids researchers working on species life-history traits and intrinsic factors influencing the fitness of both sexes, such as age. While tigers (Panthera tigris) are particularly threatened in their natural environment, few of their demographic parameters have been determined because of their solitary and elusive nature as well as low population density. Using individual-based information for more than 9200 tigers (from 1938 to 2018) recorded in the International Tiger Studbook 2018, we aimed to determine sub-species and sex-specific variability of survival and reproductive parameters with age. No significant sex-difference in actuarial senescence (i.e., decline of survival probabilities with age) was observed but males tended to have a higher juvenile mortality and a faster senescence than females. Reproductive senescence (i.e., decline of reproductive parameters with age) was more pronounced in females than males. Moreover, we observed sub-species-specific variation in mortality and reproductive patterns, pointing out the necessity to consider them independently for conservation goals. Our findings can provide meaningful improvements to the husbandry of zoo-housed tigers, emphasizing the importance of adult breeding females of 7-9 years-old to control zoo-housed population size, but also providing accurate demographic estimates, crucial to set up effective conservation plans.

Illegal Trade

Song, Z., Wang, Q., Miao, Z., Zhang, W., and Zhou, X. (2021). The dissemination of relevant information on wildlife utilization and its connection with the illegal trade in wildlife. Journal of Forestry Research, 1-11. *https://link.springer.com/article/10.1007/s11676-021-01306-y*.

ABSTRACT

We analyzed the generation and dissemination of relevant information on wildlife utilization based on the African bush elephant (Loxodonta africana Blumenbach.), the tiger (Panthera tigris L.) and the totoaba, a species of marine fish, (Totoaba macdonaldi Gilbert) as examples, whose populations are more threatened by the illegal wildlife trade. We compared the illegal

Photo from Internet

trade in wildlife with related information in order to find possible associations, searched for relevant information on major international websites to summarize similarities in information production and dissemination, and used a “Zhiwei” dissemination analysis platform to analyze the dissemination of information circulated at Microblog. The results show that the most influential information related to the trade in wildlife is mainly generated from news media websites and new self-media platforms, usually from non-governmental organizations concerned with wildlife protection. The main factors that affect the depth and breadth of disseminating relevant information on wildlife utilization include the participation of relatively influential opinion leaders, the verification ratio of forwarding users, the number of followers, and affective identification. Misleading information can stimulate and promote poaching and smuggling, regardless of their real market demand or their products. Therefore, all links in the course of information dissemination should be carefully examined in order to purify the information environment and reduce adverse effects of misleading information on wildlife protection.

MONITORING AND ASSESSMENT

Goodrich, J., Wibisono, H., Miquelle, D., Lynam, A.J., Sanderson, E., Chapman, S., Gray, T.N.E., Chanchani, P. and Harihar, A. (2021). Panthera tigris: IUCN Red List of Threatened Species. *http://dx.doi.org/10.2305/iucn.uk.2022-1.rlts.t15955a214862019.en*

GENETICS

Pandey, P., Hyun, J. Y., Yu, M., and Lee, H. (2021). Microsatellite characterization and development of unified STR panel for big cats in captivity: A case study from a Seoul Grand Park Zoo, Republic of Korea. Molecular Biology Reports, 48(2), 1935-1942. *http://dx.doi.org/10.1007/s11033-021-06202-6*.

ABSTRACT

The zoos manage small populations of endangered big cat species like tiger, lion, and leopard for display, research, and conservation breeding. Genetic management of these populations is essential to ensure long term survival and conservation utility. Here we propose a simple and cost effective microsatellite based protocol for the genetic management of captive big cats. We sampled 36 big cat individuals from Seoul Grand Park Zoo (Republic of Korea) and amplified 33 published microsatellite loci. Overall, allelic richness and gene diversity was found highest for leopards, followed by lions and tigers. Twelve of the thirty-three markers showed a high degree of polymorphism across all target species. These microsatellites provide a high degree of discrimination for tiger (1.45 × 10−8), lion (1.54 × 10−10), and leopard (1.88 × 10−12) and thus can be adopted for the genetic characterization of big cats in accredited zoos globally. During captive breeding, zoo authorities rely on pedigree records maintained in studbooks to ensure mating of genetically fit unrelated individuals. Several studies have reported errors in studbook records of big cat species. Microsatellites are simple and cost effective tool for DNA fingerprinting, estimation of genetic diversity, and paternity assessment. Our unified microsatellite panel (12-plex) for big cats is efficient and can easily be adopted by zoo authorities for regular population management.

Vaněk, D., Ehler, E., and Vaňková, L. (2021). Technical note: Development of DNA quantitation and STR typing systems for Panthera tigris species determination and individual identification in forensic casework. European Journal of Environmental Sciences, 11(2), 113-118. *http://dx.doi.org/10.14712/23361964.2021.13*.

ABSTRACT

The aim of this technical note is to provide an overview of methodical approaches used to develop molecular systems for species determination/DNA quantification called Ptig Qplex and individual identification called Ptig STRplex of Panthera tigris samples. Both systems will help to combat the illegal trade of endangered species and create a worldwide shared database of DNA profiles.

Samaha, G., Wade, C. M., Mazrier, H., Grueber, C. E., and Haase, B. (2021). Exploiting genomic synteny in Felidae: Cross-species genome alignments and SNV discovery can aid conservation management. BMC Genomics, 22(1), 601. *http://dx.doi.org/10.1186/s12864-021-07899-2*.

ABSTRACT

Background

While recent advances in genomics has enabled vast improvements in the quantification of genome-wide diversity and the identification of adaptive and deleterious alleles in model species, wildlife and non-model species have largely not reaped the same benefits. This has been attributed to the resources and infrastructure required to develop essential genomic datasets such as reference genomes. In the absence of a high-quality reference genome, cross-species alignments can provide reliable, cost-effective methods for single nucleotide variant (SNV) discovery. Here, we demonstrated the utility of cross-species genome alignment methods in gaining insights into population structure and functional genomic features in cheetah (Acinonyx jubatas), snow leopard (Panthera uncia) and Sumatran tiger (Panthera tigris sumatrae), relative to the domestic cat (Felis catus).

Results

Alignment of big cats to the domestic cat reference assembly yielded nearly complete sequence coverage of the reference genome. From this, 38,839,061 variants in cheetah, 15,504,143 in snow leopard and 13,414,953 in Sumatran tiger were discovered and annotated. This method was able to delineate population structure but limited in its ability to adequately detect rare variants. Enrichment analysis of fixed and species-specific SNVs revealed insights into adaptive traits, evolutionary history and the pathogenesis of heritable diseases.

Conclusions

The high degree of synteny among felid genomes enabled the successful application of the domestic cat reference in high-quality SNV detection. The datasets presented here provide a useful resource for future studies into population dynamics, evolutionary history and genetic and disease management of big cats. This cross-species method of variant discovery provides

genomic context for identifying annotated gene regions essential to understanding adaptive and deleterious variants that can improve conservation outcomes.

Forensic

Morgan, K. I., Ewart, K. M., Nguyen, T. Q., Sitam, F. T., Ouitavon, K., Lightson, A. L., Kotze, A., and McEwing, R. (2021). Avoiding common numts to provide reliable species identification for tiger parts. Forensic Science International: Reports, 3, 100166. *https://doi.org/10.1016/j.fsir.2020.100166*.

ABSTRACT

Tigers are killed to supply a demand for many wildlife products despite a ban on commercial international trade. As populations decrease, products from substitute species (i.e. lions and leopards) have been fraudulently sold as tiger. DNA forensic techniques are needed to definitively identify tiger in order to secure prosecutions although this is complicated by the presence of numts. Therefore, we have developed and validated a CO1 genetic marker that preferentially amplifies the mtDNA CO1 region and excludes the nuclear CO1 pseudogene, which we expect to be of use in tiger forensic casework.

ZOOLOGY AND ANIMAL WELFARE

Bartlett, S. L., Diel, D. G., Wang, L., Zec, S., Laverack, M., Martins, M., Caserta, L. C., Killian, M. L., Terio, K. A., Olmstead, C., Delaney, M. A., Stokol, T., Ivančić, M., Jenkins-Moore, M., Ingerman, K., Teegan, T., McCann, C., Thomas, P., McAloose, D., Sykes, J. M., and Calle, P. P. (2021). Sars-Cov-2 Infection and Longitudinal Fecal Screening In Malayan Tigers (Panthera Tigris Jacksoni), Amur Tigers (Panthera Tigris Altaica), And African Lions (Panthera Leo Krugeri) At The Bronx Zoo, New York, USA. Journal of Zoo and Wildlife Medicine: Official Publication of the American Association of Zoo Veterinarians, 51(4), 733-744. *http://dx.doi.org/10.1638/2020-0171*

ABSTRACT

Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) emerged as the cause of a global pandemic in 2019-2020. In March 2020, New York City became the epicenter in the United States for the pandemic. On 27 March 2020, a Malayan tiger (Panthera tigris jacksoni) at the Bronx Zoo in New York City developed a cough and wheezing with subsequent inappetence. Over the next week, an additional Malayan tiger and two Amur tigers (Panthera tigris altaica) in the same building and three lions (Panthera leo krugeri) in a separate building also became ill. The index case was anesthetized for diagnostic workup. Physical examination and bloodwork

results were unremarkable. Thoracic radiography and ultrasonography revealed a bronchial pattern with peribronchial cuffing and mild lung consolidation with alveolar-interstitial syndrome, respectively. SARS-CoV-2 RNA was identified by real-time, reverse transcriptase PCR (rRT-PCR) on oropharyngeal and nasal swabs and tracheal wash fluid. Cytologic examination of tracheal wash fluid revealed necrosis, and viral RNA was detected in necrotic cells by in situ hybridization, confirming virus-associated tissue damage. SARS-CoV-2 was isolated from the tracheal wash fluid of the index case, as well as the feces from one Amur tiger and one lion. Fecal viral RNA shedding was confirmed in all seven clinical cases and an asymptomatic Amur tiger. Respiratory signs abated within 1-5 days for most animals, although they persisted intermittently for 16 days in the index case. Fecal RNA shedding persisted for as long as 35 days beyond cessation of respiratory signs. This case series describes the clinical presentation, diagnostic evaluation, and management of tigers and lions infected with SARS-CoV-2 and describes the duration of viral RNA fecal shedding in these cases. This report documents the first known natural transmission of SARS-CoV-2 from humans to nondomestic felids.

Bullock, N., James, C., and Williams, E. (2021). Using Keeper Questionnaires to Capture Zoo-Housed Tiger (Panthera tigris) Personality: Considerations for Animal Management. Journal of Zoological and Botanical Gardens, 2(4), 650-663. *http://dx.doi.org/10.3390/jzbg2040047*

ABSTRACT

Individual personalities affect animal experiences of zoo environments, impact on an animal's coping ability and have potential implications for welfare. Keeper assessments have been identified as a quick and reliable way of capturing data on personality in a range of species and have practical application in improving animal welfare on an individual level. Despite widespread recognition of the importance of animal personality within a zoo environment, there is a paucity of research into tiger personality and the potential impact of this on tiger experiences within zoos. This research investigated the personality of 34 tigers (19 Amur and 15 Sumatran) across 14 facilities in the UK using keeper ratings and identified changes keepers made in animal husbandry to support tiger welfare. Reliability across keepers ($n = 49$) was established for nine adjectives and a principal component analysis identified three personality components: 'anxious', 'quiet' and 'sociable'. When subspecies were combined, there was no relationship between tiger scores on the personality components and age or sex of tigers ($p > 0.05$). Subspecies of tiger was not related to scores on the 'quiet' or 'sociable' components ($p > 0.05$). Sumatran tigers scored more highly than Amur tigers on the 'anxious' component (mean ± SD, Sumatran: 3.0 ± 1.7, Amur: 1.8 ± 0.6, $p < 0.05$). Analysis within subspecies found that male Amur tigers were more sociable than females (mean ± SD, males: 5.5 ± 0.707; females: 4.15 ± 0.55). Amur tiger age was also negatively correlated with scores on the sociable personality component ($R = -0.742$, $p < 0.05$). No significant differences were seen in Sumatran tigers.

Keepers reported a number of changes to husbandry routines based on their perceptions of their tigers' personality/needs. However, there was no significant relationship between these changes and tiger personality scores ($p > 0.05$). Despite significant evolutionary differences between Amur and Sumatran tigers, there are no subspecies specific guidelines for zoo tigers. This research has highlighted the potential for these two subspecies to display personality differences and we advocate further research into this area. Specifically, we highlight a need to validate the relationship between tiger personality, management protocols and behavioural and physiological metrics of welfare. This will enable a fuller understanding of the impact of personality on zoo tiger experiences and will enable identification of evidence-based best practice guidelines.

Cushing, A. C., Sawatzki, K., Grome, H. N., Puryear, W. B., Kelly, N., and Runstadler, J. (2021). Duration of Antigen Shedding and Development of Antibody Titers in Malayan Tigers (Panthera tigris jacksoni) Naturally Infected with SARS-CoV-2. Journal of Zoo and Wildlife Medicine: Official Publication of the American Association of Zoo Veterinarians, 52(4), 1224. *http://dx.doi.org/10.1638/2021-0042*

ABSTRACT

Natural infection of three captive Malayan tigers (Panthera tigris jacksoni) with SARS-CoV-2 caused mild to moderate symptoms of lethargy, anorexia, and coughing. Each tiger was longitudinally sampled opportunistically via consciously obtained oral, nasal, and/or fecal samples during and after resolution of clinical signs, until 2 wk of negative results were obtained. Persistent shedding of SARS-CoV-2 genetic material was detected via reverse transcription–polymerase chain reaction in feces up to 29 d after initial onset of clinical signs, but not in nasal or oral samples. Tigers became resistant to behavioral training to obtain nasal samples but tolerated longitudinal oral sampling. Serum was obtained from two tigers, and antibody titers revealed a robust antibody response within 9 d of onset of clinical signs, which was sustained for at least 3 mon. The tigers were infected despite the use of masks and gloves by husbandry personnel. No known cause of the outbreak was identified, despite extensive investigational efforts by the regional health department. No forward cross-species transmission was observed in primates housed in nearby enclosures. The increasing regularity of reports of SARS-CoV-2 infection in nondomestic felids warrants further investigations into shedding and immunity.

González González, G. A., and Centeno Aldana, V. (2021). Melanoma maligno cutáneo con metástasis sistémica en una hembra de tigre de bengala blanca (Panthera tigris tigris). Revista de Medicina Veterinaria, 1(43), 81-86. *http://dx.doi.org/10.19052/mv.vol1.iss43.8*

ABSTRACT

La presencia del melanoma maligno cutáneo en felinos exóticos está pobremente reportada. Una hembra de tigre de Bengala blanca (Panthera tigris tigris), de 6 años, no castrada, solitaria y viviendo en un ambiente adecuado, fue evaluada por la presencia de una masa cerca del ojo izquierdo. La histopatología de la biopsia remitida mostró la presencia de melanocitos con características anaplásicas (pleomorfismo, citomegalia, cariomegalia, binucleación), área hemorrágica y foco inflamatorio fibrinoso. El diagnóstico histopatológico fue melanoma maligno. Dos meses después del diagnóstico, la tigresa manifestó un deterioro considerable con pérdida de peso y presencia de una masa redonda en el cuello. En aquel momento, por su tamaño, el melanoma obstruía totalmente la visión. Con base en esto, y por razones humanitarias, el animal fue eutanasiado. Al momento de la necropsia, se observó metástasis en pulmones, pleura y riñones. Este caso evidencia la importancia de dar a conocer la presentación de melanomas en especies poco reportadas.

Guthrie, A., Strike, T., Patterson, S., Walker, C., Cowl, V. B., Franklin, A. D., and Powell, D. M. (2021). The past, present and future of hormonal contraceptive use in managed captive female tiger populations with a focus on the current use of deslorelin acetate. Zoo Biology, 40(4), 306-319. *http://dx.doi.org/10.1002/zoo.21601*

ABSTRACT

Tigers (Panthera tigris spp.) are endangered in the wild; ensuring sustainable insurance populations requires careful planning within zoological collections. In captive situations, contraceptives are often used to control breeding and ensure genetically viable populations that contain manageable numbers of animals; reversible contraceptives are ideal because they offer flexibility for breeding management. Historically, synthetic progestins, such as melengestrol acetate implants, were used in female tigers, but these are associated with an increased risk of reproductive pathology and subsequent infertility. Recent management advice to ex-situ collections has been to transition to the use of gonadotropin-releasing hormone agonists, such as deslorelin acetate implants, which do not appear to have a similar risk of reproductive pathology but are associated with highly variable reversal times in exotic felids. Using data from 917 contraceptive records in female tigers captured by the Association of Zoos and Aquariums Reproductive Management Center and the European Association of Zoos and Aquaria Reproductive Management Group's joint Contraception Database and from supplementary surveys, this study reviews the changing use of contraceptives in captive female tigers. The aim was to describe the historical and current use of contraceptives and provide a comprehensive assessment on the use of deslorelin implants, including data on product protocols, efficacy, pathology, and reversibility. This study determined that current

dose, frequency, reversibility, and anatomical placement sites of deslorelin implants are highly variable, indicating that specific, readily available, unified, evidence-based recommendations on the use of deslorelin would be useful for future contraceptive use in managed tiger populations.

Hensel, M. E., Wiener, D. J., and Edwards, J. F. (2021). Cutaneous Amelanotic Signet-Ring Melanoma in a Siberian Tiger (Panthera tigris altaica). Journal of Comparative Pathology, 189, 141-144. *http://dx.doi.org/10.1016/j.jcpa.2021.10.009*

ABSTRACT

A 15-year-old male white Siberian tiger (Panthera tigris altaica) was evaluated for an elevated, ulcerated, cutaneous mass on the right flank. The mass was removed by excisional biopsy and submitted for histopathology. Based on distinct histological features of intracytoplasmic globular material and positive immunohistochemical staining for Melan-A and vimentin, an amelanotic signet-ring melanoma was diagnosed. While in domestic cats this neoplasm is associated with malignancy and a short survival time, the tiger had no local recurrence or related clinical disease approximately 4 years post surgery. Cutaneous melanocytic tumours are rare in big cats, and the findings in this case suggest that amelanotic signet-ring melanoma is not as malignant as its counterpart in domestic cats.

Matthews, M., Hilliard, B., Pearson, M., and Waggoner, A. (2021). Spontaneous Disseminated Histiocytic Sarcoma in a Bengal Tiger (Panthera tigris tigris). Journal of Comparative Pathology, 188, 32-36. *http://dx.doi.org/10.1016/j.jcpa.2021.08.007*

ABSTRACT

A 16-year-old, female, captive Bengal tiger (Panthera tigris tigris) had a history of a recurrent subcutaneous mass. After two attempts at surgical removal, euthanasia was elected during the third surgical attempt due to the degree of neoplastic infiltration. At necropsy, a large subcutaneous mass infiltrated the dermis, subcutis and abdominal wall with metastasis to the lungs, spleen and adrenal glands. Microscopically, the neoplasm formed nodules comprising sheets of round cells with large irregular nuclei. Toluidine blue and Giemsa stains were negative. An immunohistochemistry panel revealed membranous and cytoplasmic labelling with ionized calcium-binding adaptor molecule 1 (IBA1), cytoplasmic labelling with vimentin but no labelling with multiple myeloma oncogene 1 (MUM1), CD20 or pancytokeratin markers. Based on the gross distribution and histological and immunohistochemistry features, a diagnosis of disseminated histiocytic sarcoma was made. To the best of our knowledge, this is the first record of disseminated histiocytic sarcoma in a captive Bengal tiger.

Mota, S. M., Brandão, J., and Guthrie, A. (2021). Comparison of Blood Symmetric Dimethylarginine and Creatinine as Endogenous Markers of Kidney Function in Captive Tigers (Panthera Tigris). Journal of Zoo and Wildlife Medicine: Official Publication of the American Association of Zoo Veterinarians, 52(2), 628-637. *http://dx.doi.org/10.1638/2020-0032*

ABSTRACT

Chronic kidney disease (CKD) is a common cause of morbidity and mortality in captive tigers (Panthera tigris). Blood creatinine (Cr) and blood urea nitrogen measurements are inexpensive and common biomarkers used to evaluate renal function. However, several limitations have been reported regarding their sensitivity and interindividual variability. Symmetric dimethylarginine (SDMA) has been suggested to be a more sensitive biomarker that is less affected by extrarenal factors and has a strong correlation with glomerular filtration rate and blood Cr in several species. This project aimed to identify the usefulness of SDMA as an endogenous marker of kidney function in captive tigers. The hypothesis of this study is that increased circulating SDMA is positively associated with increased blood Cr. SDMA and Cr were measured in 65 banked samples (serum and plasma) from 30 individual captive tigers. The samples were collected over a 38-y period and stored at -21°C. SDMA and Cr concentrations were determined using the commercially available SDMA test and enzymatic colorimetric methods, respectively. SDMA had a significant positive association with Cr (for every 1 unit increase of log SDMA, Cr increased by 82%, P = 0.0002). Age and subspecies influenced Cr but not SDMA concentrations. In one animal, blood SDMA increased above the ZIMS reported range. approximately 3.6 mo before Cr increased. SDMA is currently indicated for the diagnosis of CKD in domestic felids and seems also promising in nondomestic felids. Further prospective studies might improve the understanding of the performance of this biomarker.

Mulreany, L. M., Ramsay, E. C., Cushing, A. C., Suchodolski, J. S., Lidbury, J. A., and Steiner, J. M. (2021). Exocrine Pancreatic Insufficiency-Like Syndrome in Four Captive Tigers (Panthera Tigris). Journal of Zoo and Wildlife Medicine: Official Publication of the American Association of Zoo Veterinarians, 52(3), 1079-1083. *http://dx.doi.org/10.1638/2019-0195*

ABSTRACT

Exocrine pancreatic insufficiency (EPI) is a condition characterized by a decreased synthesis and secretion of pancreatic enzymes, which results in weight loss, poor hair coat, and diarrhea. The diagnostic test of choice for EPI in domestic cats is feline serum trypsin-like immunoreactivity (fTLI). This paper details four tigers (Panthera tigris) with clinical signs compatible with EPI. On the basis of domestic cat reference ranges, fTLI assays for all four clinically affected tigers were diagnostic for EPI (median 1.0 µg/L; range 0.5-1.2 µg/L). All four tigers had a rapid clinical

response to pancreatic enzyme supplementation. Serum from 10 clinically healthy tigers was submitted for the fTLI assay, for comparative purposes. The healthy tigers' fTLI assays were also within range for a diagnosis of EPI in domestic cats (median 3.1 µg/L; range 1.9-4.5 µg/L); however, clinically affected tigers had significantly lower serum fTLI concentrations than healthy tigers (P = 0.0058). Serum cobalamin was below the detection limit in both the affected and healthy tigers (<150 ng/L). Measuring fTLI appears to be a useful tool in the diagnosis of EPI-like syndrome in tigers. As in other species, EPI-like syndrome in tigers may also be associated with cobalamin deficiency.

Hatam-Nahavandi, K., Calero-Bernal, R., Rahimi, M. T., Pagheh, A. S., Zarean, M., Dezhkam, A., and Ahmadpour, E. (2021). Toxoplasma gondii infection in domestic and wild felids as public health concerns: a systematic review and meta-analysis. Scientific Reports, 11(1), 9509. *http://dx.doi.org/10.1038/s41598-021-89031-8*.

ABSTRACT

Felidae as definitive hosts for Toxoplasma gondii play a major role in transmission to all warm-blooded animals trough oocysts dissemination. Therefore, the current comprehensive study was performed to determine the global status of T. gondii infection in domestic and wild felids aiming to provide comprehensive data of interest for further intervention approaching the One Health perspective. Different databases were searched by utilizing particular key words for publications related to T. gondii infecting domestic and wild feline host species, worldwide, from 1970 to 2020. The review of 337 reports showed that the seroprevalence of T. gondii in domestic cats and wild felids was estimated in 37.5% (95% CI 34.7–40.3) (I2 = 98.3%, P < 0.001) and 64% (95% CI 60–67.9) (I2 = 88%, P < 0.0001), respectively. The global pooled prevalence of oocysts in the fecal examined specimens from domestic cats was estimated in 2.6% (95% CI 1.9–3.3) (I2 = 96.1%, P < 0.0001), and that in fecal samples from wild felids was estimated in 2.4% (95% CI 1.1–4.2) (I2 = 86.4%, P < 0.0001). In addition, from 13,252 examined soil samples in 14 reviewed studies, the pooled occurrence of T. gondii oocysts was determined in 16.2% (95% CI 7.66–27.03%). The observed high rates of anti-T. gondii antibodies seroprevalence levels and oocyst excretion frequency in the felids, along with soil (environmental) contamination with oocysts may constitute a potential threat to animal and public health, and data will result of interest in further prophylaxis programs.

Herranz-Rodrigo, D., Tardáguila-Giacomozzi, S. J., Courtenay, L. A., Rodríguez-Alba, J. J., Garrucho, A., Recuero, J., and Yravedra, J. (2021). New Geometric Morphometric Insights in Digital Taphonomy: Analyses into the Sexual Dimorphism of Felids through Their Tooth Pits. Applied Sciences, 11(17), 7848. *http://dx.doi.org/10.3390/app11177848*

ABSTRACT

Recent studies using geometric morphometrics for taphonomy have yielded interesting results, opening new horizons of research in both archaeological and paleontological sites. Here we present the analysis of tooth pits left by male and female individuals of two different carnivore species (Panthera tigris and Panthera pardus) in order to see if sexual dimorphism influences the morphology of tooth pit marks. In the process, 3D-scanning and applied statistics were used. Based on samples derived from two individuals of different sexes, the present results indicate sexual dimorphism in these felid species to not be a conditioning factor of tooth pit morphology.

Owens, C. D., Michau, T. M., Boorstein, J., Wynn, E. R., and McMullen, R. J. (2021). Keratometry, biometry, and prediction of intraocular lens power in adult tigers (Panthera tigris). American Journal of Veterinary Research, 83(2), 140-146. *http://dx.doi.org/10.2460/ajvr.21.04.0060*

ABSTRACT

Objective: To calculate the necessary pseudophakic intraocular lens (IOL) power to approximate emmetropia in adult tigers. Animals: 17 clinically normal adult tigers. Procedures: 33 eyes of 17 clinically normal adult tigers underwent routine ophthalmic examination and B-scan ultrasonography while anesthetized for unrelated procedures. Specific ultrasound data (globe measurements and corneal curvature) and estimated postoperative IOL positions were utilized to calculate predicted IOL power by use of Retzlaff and Binkhorst theoretical formulas. Applanation tonometry and refraction were also performed. Results: Mean ± SD axial globe length was 29.36 ± 0.82 mm, preoperative anterior chamber depth was 7.00 ± 0.74 mm, and crystalline lens thickness was 8.72 ± 0.56 mm. Mean net refractive error (n = 33 eyes) was +0.27 ± 0.30 diopters (D). By use of the Retzlaff formula, mean predicted IOL power for the postoperative anterior chamber depth (PACD), PACD - 2 mm, and PACD + 2 mm was 43.72 ± 4.84 D, 37.62 ± 4.19 D, and 51.57 ± 5.72 D, respectively. By use of the Binkhorst equation, these values were 45.11 ± 4.91 D, 38.84 ± 4.25 D, and 53.18 ± 5.81 D, respectively. Mean intraocular pressure for all eyes was 14.7 ± 2.69 mm Hg. Clinical relevance: The calculated tiger IOL was lower than reported values for adult domestic felids. Further studies evaluating actual PACD and pseudophakic refraction would help determine the appropriate IOL power to achieve emmetropia in this species.

Proverbio, D., Perego, R., Baggiani, L., Ravasio, G., Giambellini, D., and Spada, E. (2021). Hematological and Biochemical Reference Values in Healthy Captive Tigers (Panthera tigris). Animals, 11(12), 3440. *http://dx.doi.org/10.3390/ani11123440*.

ABSTRACT

The tiger (Panthera tigris) is an endangered species. The health of individuals is important and any data on hematological and biochemical blood values can provide valuable information; when combined with physical assessment. This data assists in both the diagnosis of disease and some conservation strategies. The behavior of wild tigers makes it is extremely difficult to obtain biological samples from free-living subjects, therefore, data collected from captive tigers is highly valuable. The aim of this study was to provide additional information for the values of hematological and serum biochemical parameters in healthy captive tigers. Blood samples were collected from 22 clinically healthy tigers (Panthera tigris). The following parameters were analyzed: glucose, urea, creatinine, alanine aminotransferase (ALT), alkaline phosphatase (ALP), total protein (TP) and red blood cells (RBCs), hemoglobin (Hb), hematocrit (Hct) and red cell indices; such as mean cell volume (MCV), mean cell Hb (MCH), mean cell Hb concentration (MCHC), platelet (PLT) and white blood cells (WBCs). The mean hematological values in our tiger population were not significantly different when compared with the same parameters in the previously studied tiger population. The mean values of RBCs and PLT were statistically significantly higher and the mean values of Hb, PCV, MCV, MCH, MCHC, and WBC were lower than the mean values obtained in previous studies on the Amur tiger. Further investigation of captive and free-living tigers is needed to identify the normal ranges for parameters in this endangered species.

Rangel, M., and Da Silva Júnior, N. (2021). Environmental food and cognitive enrichment: A study of well-being for large captive felids at the Zoo of Goiânia. Research Square. *http://dx.doi.org/10.21203/rs.3.rs-395609/v1*.

ABSTRACT

In order to promote research and conservation of species, zoos tend to promote the modernization of this system, such as the insertion of larger and adequate enclosures, environmental enrichments, and above all the conservation of species. The main objectives of this work were: to promote environmental food and cognitive enrichment for big cats, in addition to discussing the validity of this enrichment model. The study animals were 12 animals: four tigers (Panthera tigris), three puma (Puma concolor), three jaguars (Panthera onca) and two lions (Panthera leo). We used a basic ethogram for the analysis of behaviors, in which there was an analysis of specific behavior: rhythm and inactivity. With the focal animal observation method, and using the "surprise box" enrichment method, which consisted of pieces of meat inside cardboard boxes, the statistical results obtained indicated that enrichment increased social, rest and physiological behavior, and slowed down and downtime. Each species reacted in a specific way to enrichments, with better results being noticed with the Panthera onca

group, followed by the Panthera leo, Panthera tigris and Puma concolor group, respectively. The theory of the use of environmental enrichment was proven and compared with other works similar to this one.

Schaff, A. R., Ferguson, S. H., Phair, K., Ferris, R. L., and Goe, A. (2021). Eumycetoma and disseminated phaeohyphomycosis in a Sumatran tiger. Journal of Veterinary Diagnostic Investigation: Official Publication of the American Association of Veterinary Laboratory Diagnosticians, Inc, 33(6), 1197-1201. *http://dx.doi.org/10.1177/10406387211038920*

ABSTRACT

A 16-y-old female Sumatran tiger (Panthera tigris sumatrae) was evaluated for hyporexia. Examination revealed chronic kidney disease and a large subcutaneous axillary mass with draining tracts that contained numerous small black grains. Histologic examination revealed the presence of intralesional fungal hyphae. Persistent hyporexia and pyogranulomatous disease, as well as progressive cachexia and azotemia occurred despite treatment, and euthanasia was performed. Disseminated phaeohyphomycosis was diagnosed on postmortem examination, additionally affecting various lymph nodes, the nasal cavity, mesenteric adipose tissue, abdominal aorta, pericardium, and kidney. Fungal culture from a deep-tissue sample isolated a pure growth of Curvularia sp., a dematiaceous opportunistic fungus able to cause eumycetomas and/or phaeohyphomycosis. Phaeohyphomycosis is a rare but emerging condition, not previously reported as disseminated disease in an exotic carnivore, to our knowledge. Aggressive systemic antifungal treatment was unsuccessful, likely complicated by diagnostic challenges and concurrent renal disease. The presence of a swelling with abundant grains exiting draining tracts should direct clinicians to the diagnosis of a mycetoma, warranting early and aggressive treatment.

Stout, A. E., André, N. M., and Whittaker, G. R. (2021). Feline Coronavirus and Feline Infectious Peritonitis in Nondomestic Felid Species. Journal of Zoo and Wildlife Medicine: Official Publication of the American Association of Zoo Veterinarians, 52(1), 14-27. *http://dx.doi.org/10.1638/2020-0134*

ABSTRACT

Feline coronavirus (FCoV) is reported worldwide and known to cause disease in domestic and nondomestic felid species. Although FCoV often results in mild to inapparent disease, a small subset of cats succumb to the fatal, systemic disease feline infectious peritonitis (FIP). An outbreak of FIP in Cheetahs (Acinonyx jubatus) in a zoological collection demonstrated the devastating effect of FCoV introduction into a naïve group of animals. In addition to cheetahs,

FIP has been described in European wildcats (Felis silvestris), a tiger (Panthera tigris), a mountain lion (Puma concolor), and lion (Panthera leo). This paper reviews the reported cases of FIP in nondomestic felid species and highlights the surveys of FCoV in populations of nondomestic felids.

Do Vale, B., Lopes, A. P., Fontes, M. da C., Silvestre, M., Cardoso, L., and Coelho, A. C. (2021). Bats, pangolins, minks and other animals - villains or victims of SARS-CoV-2? Veterinary Research Communications, 45(1), 1-19. *http://dx.doi.org/10.1007/s11259-021-09787-2*

ABSTRACT

Coronavirus disease-19 (COVID-19) is caused by the severe acute Respiratory syndrome coronavirus-2 (SARS-CoV-2), which has become unstoppable, spreading rapidly worldwide and, consequently, reaching a pandemic level. This review aims to provide the information available so far on the likely animal origin of SARS-CoV-2 and its possible hosts/reservoirs as well as all natural animal infections and experimental evidence using animal models. Horseshoe bats from the species Rhinolophus affinis seem to be a natural reservoir and pangolins (Manis javanica) appear to be an intermediate host of SARS-CoV-2. Humans remain the most likely spreading source of SARS-CoV-2 to other humans and also to domestic, zoo and farm animals. Indeed, human-to-animal transmission has been reported in cats, dogs, tigers, lions, a puma and minks. Animal-to-human transmission is not a sustained pathway, although mink-to-human transmission remains to be elucidated. Through experimental infections, other animals seem also to be susceptible hosts for SARS-CoV-2, namely ferrets, some non-human primate species, hamsters and transgenic mice, while dogs, pigs and poultry are resistant. A One Health perspective must be implemented in order to develop epidemiological surveillance and establish disease control mechanisms to limit zoonotic transmission. Moreover, research in this field is important to better understand SARS-CoV-2 and to obtain the long-awaited vaccine and specific treatment.

Viere, A. R., Cushing, A. C., Ramsay, E. C., and Craig, L. E. (2021). A Retrospective Study of Brain Lesions in Captive Nondomestic Felids. Journal of Zoo and Wildlife Medicine: Official Publication of the American Association of Zoo Veterinarians, 52(3), 918-925. *http://dx.doi.org/10.1638/2021-0016*

ABSTRACT

This retrospective study identified and characterized brain lesions in captive nondomestic felids from a large cat sanctuary. Necropsy reports from January 2002 through December 2018 were examined, and gross images and microscopic slides were reviewed from individual cats, where available. In total, 255 cats met the following inclusion criteria: complete necropsy report available, brain examined grossly or microscopically, and age of >1 mon. Of the 255 cats, 49 cats (19%) were determined to have brain lesions. Eleven different felid species, as well as one captive-bred hybrid (liger), were included in the study, with tigers (Panthera tigris) (55%) and lions (Panthera leo) (18%) being the most common species. Lesions were grouped into six etiologic categories: neoplastic (32%), vascular (26%), inflammatory or infectious (20%), congenital (9%), idiopathic (7%), and metabolic (6%). Not included in these categorized lesions were previously undescribed amphophilic globules in the cerebral cortex of many cats with and without other brain lesions; these were in 95% of lion and 93% of tiger brains where the cerebral cortex was available for histologic examination. These globules were not associated with clinical disease. The histopathologic and gross brain changes documented in this study provide insight into specific diseases and pathologic processes that affect the brains of captive large cat populations.

Nilanjan Chatterjee

INDIA

HUMAN WILDLIFE INETRACTION AND CONFLICT MITIGATION

Badola, R., Ahmed, T., Gill, A. K., Dobriyal, P., Das, G. C., Badola, S., and Hussain, S. A. (2021). An incentive-based mitigation strategy to encourage coexistence of large mammals and humans along the foothills of Indian Western Himalayas. Scientific Reports, 11(1), 5235-5235. *http://dx.doi.org/10.1038/s41598-021-84119-7*

ABSTRACT

Escalation of human–wildlife conflict (HWC) is a barrier to the conservation of ecological corridors across the globe. The existing mechanisms to counter HWC are either economically and socially taxing, or ineffective for long-term management. We assessed HWC in the corridor linking the Rajaji and Corbett Tiger Reserves in Uttarakhand, India, and its drivers, along with the benefits derived by local communities from the forest. We designed an innovative incentive-based mitigation mechanism to encourage coexistence of people and wildlife around the corridor. Costs incurred due to conflict and benefits derived from the forest were assessed using semi-structured questionnaire-based personal interviews (n = 757) with representatives from forest dependent households (hh). Fuelwood (1678.7 ± 131 kg hh−1 year−1), fodder (4772 ± 186 kg hh−1 year−1) and green/dry grass (3359 ± 104 kg hh−1 year−1) contributed 3 ± 1%, 6 ± 0.5% and 9 ± 1%, respectively, to the annual income of dependent households. 69% of the households practising agriculture reported crop damage by wild animals, 19% of the households that owned livestock reported livestock loss, and 1.58% reported attack on humans resulting in injuries. The cost incurred due to crop raiding and livestock depredation was US $ 159.83 ± 1.0 hh−1 year−1 and US $ 229.32 ± 34.0 hh−1 year−1, respectively. Crop loss was positively associated with the number of crops grown per season and cultivation of sugarcane, wheat and pulses, and negatively with distance from forest and cultivation of fodder and finger millet. Livestock depredation was negatively associated with distance from forest and positively with number of livestock owned, primarily calves. The accounting profit from cultivating a hectare of land, in the absence of crop depredation by wild animals, was estimated at US $ 3571.84 ha−1 year−1 and US $ 361.44 ha−1 year−1 for the plains and hills, respectively. This value can be used to calculate the payments to be paid to local communities to encourage them to adopt HWC resistant agricultural and pastoralism practices. The net present value of benefits from participating in the payments to encourage coexistence programme for 5 years, discounted at 12%, was US $ 12,875.7 ha−1 for the plains and US $ 1302.9 ha−1 for the hills.

Kanchan, T., Shekhawat, R. S., Shetty, B. S. K., Jayaram, L., and Meshram, V. P. (2021). Fatal captive tiger attack – A case report with review of literature. Journal of Forensic and Legal Medicine, 78, 102100. *https://doi.org/10.1016/j.jflm.2020.102100*.

ABSTRACT

The attacks on humans by big captive felids has been an issue of concern for the administration of zoological parks and wildlife conservationists. The theme of human-animal conflict takes a new dimension for the wild animals kept in zoos, circuses, exotic animal farms, and private custody. Despite the potential dangers involved, the zookeepers have to closely interact with the captive tigers for catering to the needs of food, general health, and wellbeing. The literature has described cases of attacks by captive tigers resulting in the death of the primary caretaker. The injuries present on such bodies include multiple punctured lacerations, traumatic amputations, damage to the vital organs of the neck, fracture-dislocation of cervical vertebrae, and abrasions secondary to the dragging of the body. We present a rare fatal case of an attack of a tiger on keeper during the night hours while he entered the cage to look after the tiger who was suffering from gastroenteritis for a few days and was not taking his feed aptly. The keeper had a twelve-year long relation with the tiger, and the discovery of his death was an astonishment for zoo administration. This case describes the autopsy findings emphasizing the distribution of injuries, along with inquiring into the scene of the incident. The details about the predatory behaviour of tigers and stereotypic behaviours in captivity have been discussed.

Nair, R., Dhee, Patil, O., Surve, N., Andheria, A., Linnell, J. D. C., and Athreya, V. (2021). Sharing Spaces and Entanglements with Big Cats: The Warli and Their Waghoba in Maharashtra, India. Frontiers in Conservation Science, 2, 683356. *http://dx.doi.org/10.3389/fcosc.2021.683356*

ABSTRACT

Long histories of sharing space and resources have built complex, robust, and enduring relationships between humans and wildlife in many communities across the world. In order to understand what makes it possible for humans and wildlife to share space, we have to look beyond the ecological and socio-economic study of damages caused by human-wildlife conflict and explore the cultural and societal context within which co-existence is embedded. We conducted an exploratory study on the institution of Waghoba, a big cat deity worshiped by the Indigenous Warli community in Maharashtra, India. Through our research, we found that the worship of Waghoba is highly prevalent, with 150 shrines dedicated to this deity across our study site. We also learnt that the Warlis believe in a reciprocal relationship, where Waghoba will protect them from the negative impacts of sharing spaces with big cats if the people worship the deity and conduct the required rituals, especially the annual festival of Waghbaras. We propose that such relationships facilitate the sharing spaces between humans and leopards that live in the landscape. The study also revealed the ways in which the range of institutions and stakeholders in the landscape shape the institution of Waghoba and thereby contribute to the human-leopard relationship in the landscape. This is relevant for present-day wildlife conservation because such traditional institutions are likely to act as tolerance-building mechanisms embedded within the local cosmology. Further, it is vital that the dominant stakeholders outside of the Warli community (such as the Forest Department, conservation biologists, and other non-Warli residents who interact with leopards) are informed about and sensitive to these cultural representations because it is not just the biological animal that the Warlis predominantly deal with.

Conflict (people's perception)

Doubleday, K. F., and Rubino, E. C. (2021). Tigers bringing risk and security: Gendered perceptions of tiger reintroduction in Rajasthan, India. Ambio, 51(5), 1-9. *http://dx.doi.org/10.1007/s13280-021-01649-0*

ABSTRACT

Human–wildlife conflict has been documented to impact some communities heterogeneously, particularly along gender lines (e.g., women experiencing inequitably increased workloads and economic hardship, and decreased physical safety and psychological wellbeing), leading to different attitudes towards wildlife. Despite possible gendered discrepancies, women's perceptions of conservation management are often insufficiently explored, leading to incomplete understandings of conservation dynamics, and unjust conservation policies. In an effort to investigate if and how perceptions of tiger reintroductions are disparate, we conducted focus group discussions with women and men living in and around Sariska Tiger Reserve in Rajasthan, India. Results demonstrate clear gendered delineations in perceptions, where male participants predominantly focused on economic and ecological benefits, and female participants highlighted threats to personal safety and hidden costs (e.g., potential abuse, dowry concerns). This research underscores the importance of documenting and understanding gendered perceptions of carnivores to achieve the broad community support necessary for successful reintroduction efforts worldwide.

Vasudeva, V., Ramasamy, P., Pal, R.S., Behera, G., Karat, P.R. and Krishnamurthy, R., 2021. Factors influencing people's response toward tiger translocation in Satkosia Tiger Reserve, Eastern India. Frontiers in Conservation Science, 2, 664897. DOI=10.3389/fcosc.2021.664897

ABSTRACT

Local communities are an important stakeholder in any carnivore translocation programme and therefore, their acceptance of the translocation and support are essential to ensure its viability. Recent tiger augmentation efforts in Satkosia Tiger Reserve, India received mixed responses from the local communities, causing a stalemate in its progress. As a part of the adaptive management strategy, it was required to assess the concerns and issues to provide a practical solution. Hence, we analyzed the attitude of the people toward conservation in general and tiger specifically. We used structured questionnaire surveys and interviewed 1,932 households from 43 villages located in and around the reserve. We tested the influence of several variables representing four categories- (1) socio-economic, (2) ecosystem values and dependence, (3) relationship with the forest department and (4) losses and fear, on the attitude toward tiger conservation. The villages were clustered based on the responses received under these categories. While conserving forest was important to 91% of respondents, 71% of respondents supported wildlife conservation and only 35% felt important to conserve tiger. The logistic binary regression predicted that at the household level attitude toward tiger conservation is influenced positively by economic well-being, sense of forest ecosystem services, resource dependence and negatively influenced by restrictions from the forest department, and previous experience of loss due to wildlife. At the village level, literacy, resource dependence, access to clean cooking fuel and cooperation from the forest department predicted a positive attitude toward tiger conservation. Restriction from the forest department, fear for livestock, and experience of losses due to wildlife had a negative influence on attitude. We recommend that the villages in the landscape are prioritized based on their needs and accordingly, specific

interventions are made to address their concerns. Future augmentation programme must give importance to intangible factors such as fear and perceived restrictions and opt for the involvement of the local community in the decision-making process.

CONSERVATION, MANAGEMENT AND POLICY RECOMMENDATION

Bhardwaj, G. S., Kari, B., and Mathur, A. (2021). Utilisation of honey trap method to ensnare a dispersing sub-adult Bengal Tiger Panthera tigris tigris L. in a human dominated landscape. Journal of Threatened Taxa, 13(8), 19153-19155.
http://dx.doi.org/10.11609/jott.6476.13.8.19153-19155.

ABSTRACT

The need to conserve the tiger, an endangered species and avoid interactions with humans is among the main objectives of forest management of tiger reserves in India. The objective of the study is show that male tigers can be trapped by pheromones in urine and feces of tigress for subsequent translocation. A sub-adult male tiger strayed out of Sariska Tiger Reserve into the human dominated areas to look for territory. Attempts to tranquilize the tiger failed due to dense vegetation. Then the urine and feces of a captive tigress was used to trail the tiger, capture him, and release him into his natal area thereby avoiding incidents with humans. Tracking data indicated that the tiger had settled in the northern area part of Sariska and subsequently sired seven cubs with two tigresses.

Dube, P. (2021). Social Factors Affecting the Conservation of Tigers in the Samsher Nagar Area of Sunderbans. Asian Journal of Biology, 12(2), 12-23.
https://doi.org/10.9734/AJOB/2021/v12i230158.
http://dx.doi.org/10.9734/ajob/2021/v12i230158

ABSTRACT

Increased human populations and the resulting encroachment of related lands with poaching of tigers and their key prey threaten the survival of tigers across their range. Mere collection of huge data on ecology does not promote the protection of carnivores but it mainly depends on public co-operation and awareness. The public attitude towards carnivores (Panthera tigris tigris) is vital because fear pervades among the local inhabitants. Our target population consisted of all adults inhabitants. We sampled arbitrarily founded on geographic area. We guessed that the best data collection method would involve sampling at home of the residents by personal interview with the questionnaires due to huge illiteracy of the inhabitants. Proceeding this way was time-consuming but proved to increase the quality of responses. We studied villagers' mind-set and collected information on public awareness, feelings and frequency of sightings related to the tigers. They were conscious of its existence and aware of its ecological values to conserve Sunderbans also. To better understand the social factors affecting large carnivore conservation, we surveyed the tiger-affected people, the relatives of the people killed by tigers and the common villagers in the village of Samser nagar of Sunderbans, West Bengal, in India. People living in this area are heavily dependent on forest for their livelihood. They collect honey and catch crabs and fish seedlings from the jungle. Nowadays, many tourists came to see flora and fauna and the eternal beauty of Sunderbans. Many people depend their livelihood on tourism. These social factors make them to think to save Sunderbans. If Sunderbans is destroyed in near future, then they will suffer economically. A financial constraint of the inhabitants to protect the human lives and cattle from the attack of tigers was revealed by choosing the category willing to conserve but not afforded to pay. This study was the first assessment of public responsiveness and exposed the basic data for understanding Bengal tigers in the area of Samsher nagar of Sunderbans.

Jhala, Y., Gopal, R., Mathur, V., et al. (2021). Recovery of tigers in India: Critical introspection and potential lessons. People and Nature, 3, 281–293. *https://doi.org/10.1002/pan3.10177*.

ABSTRACT

In a world where biodiversity is on the decline, examples of conservation success especially of large carnivores are of interest to policy makers and conservation practitioners. Herein, we elucidate the conservation actions that have been responsible for the recovery of tigers and their ecosystems in India; a feat many range countries are struggling to achieve. Demand-driven poaching resulted in extinctions at two prestigious Tiger Reserves. India's Prime Minister constituted a Tiger Task Force that led to the formation of the National Tiger Conservation Authority, the Wildlife Crime Control Bureau, scientific monitoring of tiger populations and incentivized voluntary relocation of human settlements from tiger reserves. Tiger Conservation Plans, cognizant of constraints imposed by small reserves embedded in human land uses, aimed to create source populations within tiger reserves with corridor links between sources and to sink habitats. Metapopulation management enhanced occupancy and long-term viability of tiger populations. Tiger Protection Force and technology like MSTrIPES, E-eye and drones effectively reduced poaching. Community support was attempted through profit sharing, mitigating human–tiger conflict with a fast, fair and transparent compensation process and removal of problem tigers. Reintroduction and reinforcement of tigers and prey assisted natural recovery. Political will ensured resources. Tigers were monitored using Spatially Explicit Capture–Recapture with camera traps and ecological covariates. In 2018–2019 from 381,000 km^2 of tiger habitat, 89,000 km^2 was occupied. Currently, 50 tiger reserves cover 72,750 km^2 and harbour 65% of India's ~3,000 tigers. Tiger reserves are managed with an

annual investment of ~1,000 USD/km² with one staff per 6.5 km². Tiger reserves were regularly evaluated for Management Effectiveness. Tiger reserves were valued to have benefit flows between 76,900 and 292,300 US$ km−2year−1.In the Anthropocene it is unlikely that tigers will survive without targeted conservation investments. Political commitment and resources can become available for conservation when people and tigers benefit simultaneously. Conscious balance by governments between development for rapid economic prosperity and long-term ecological security will ensure that wild tigers and their intact ecosystems will survive for future generations.

Mungi, N. A., Qureshi, Q., and Jhala, Y. V. (2021). Role of species richness and human impacts in resisting invasive species in tropical forests. Journal of Ecology, 109, 3308–3321. *https://doi.org/10.1111/1365-2745.13751*.

ABSTRACT

The biotic resistance hypothesis suggests that biodiversity- rich areas should be resistant to biological invasions. Globally, conservationists use this hypothesis to protect diverse ecosystems. However, supporting data are often contradictory, possibly due to several confounding factors. Complexity in inferences increases in the tropics, which are sparsely studied.2. We hypothesize that human impacts, forest type and climate would modulate the relationship between native and invasive plant richness. To understand these in-teracting and varying effects of native richness and human disturbance on plant invasions, we sampled 354 grids of 25 km² with equal representation of protected areas (PAs) and multi-use areas (MAs) to record abundance of native and non- native plants from 34 PAs across five forest types in tropical India. We used lin-ear mixed effect models to investigate the occurrence and abundance of invasive plants with respect to varying native richness, human impacts, forest types and climate.3. Human use of forests increased the richness and abundance of invasive plants across all forest types. After accounting for human use, native species richness of tropical wet forests had a negative relationship with invasive plants richness and abundance, while the relationship reversed with increasing aridity and tempera-ture. Human infrastructure facilitated invasions within PAs.4. Synthesis. The biotic resistance hypothesis explained a lower number of inva-sions within protected tropical wet forests but not within dry forests. Human- free protected areas had lower richness and abundance of invasive plants across all systems, especially in wet tropical forests. Our results support the contextual importance of the biotic resistance hypothesis, while stressing the importance of protected areas, insulated from human impacts, to preserve the integrity of vul-nerable natural systems.

Palmeirim, A. F., and Gibson, L. (2021). Impacts of hydropower on the habitat of jaguars and tigers. Communications Biology, 4, 1358. *http://dx.doi.org/10.1038/s42003-021-02878-5*.

ABSTRACT

The rapid expansion of hydropower across tropical landscapes has caused extensive habitat loss and degradation, triggering biodiversity loss. Despite known risks to freshwater biodiversity, the flooding of terrestrial habitats caused by dam construction, and associated impacts on terrestrial biota, have been rarely considered. To help fill this knowledge gap, we quantified the habitat loss following inundation of hydropower reservoirs across the range of two iconic species, jaguars and tigers. To do so, we compiled existing and planned dams intersecting the distribution of these apex predators. We found 164 dams intersecting the jaguar range, in total flooding 25,397 km². For tigers, we identified 421 dams, amounting to 13,750 km². As hydropower infrastructure is projected to expand in the decades ahead, these values are expected to increase greatly, particularly within the distribution of jaguars where the number of dams will nearly quadruple (429 planned dams). Despite the relatively few dams (41) planned across the range of tigers, most will intersect priority conservation areas for this species. We recommend a more cautious pursuit of hydropower in topographically flat regions, to avoid extensive habitat flooding which has occurred in the Neotropics, and avoiding dam construction in priority conservation landscapes for tigers.

Sethi, S. (2021). Insights into illegal wildlife hunting by forest guards of selected tiger reserves in Central India. European Journal of Wildlife Research, 68(1). *http://dx.doi.org/10.1007/s10344-021-01553-8*.

ABSTRACT

Illegal wildlife hunting is an anthropogenic threat to global fauna with a cascading detrimental effect on the ecosystems. India imposed a blanket ban on hunting of all indigenous species (except Schedule V species) in 1991 (Wildlife (Protection) Act, 1972 amended) yet, wildlife hunting continues in a clandestine nature. The study is aimed at addressing three key issues: (i) drivers of illegal hunting, hunting practices, and trends in illegal hunting in the last decade; (ii) reasons for the dependence of local communities on protected areas; and (iii) awareness of the law among the local communities, through the lens of frontline-forest staff. An exploratory analysis is presented by surveying 415 forest guards. The results highlight (i) rising threat of retaliation hunting especially using electrical wires and snares, (ii) a perceived decline in illegal hunting trends in the last decade, (iii) dependence of local communities on firewood and non-timber forest produce, and (iv) there is awareness about the wildlife laws and policies at the grass-root level. This research provides insights for harnessing the knowledge of the

forest guards for improving conservation strategies of protected areas, especially in the Tiger Landscapes of India.

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Adhikarimayum, A. S. (2021). Aspects of Ecology of Large Carnivores and Their Prey in and Around Dibang Wildlife Sanctuary, Arunachal Pradesh, India (Doctoral dissertation). Saurashtra University.

Bhandari, A., Ghaskadbi, P., Nigam, P., and Habib, B. (2021). Dhole pack size variation: Assessing the effect of prey availability and apex predator. Ecology and Evolution, 11(9), 4774-4785. *http://dx.doi.org/10.1002/ece3.7380*.

ABSTRACT

In multi-predator systems, group sizes of social carnivores are shaped by the asymmetric intraguild interactions. Subordinate social carnivores experience low recruitment rates as an outcome of predation pressure. In South and Southeast Asia, the Tiger (Panthera tigris), Dhole (Cuon alpinus), and Leopard (Panthera pardus) form a widely distributed sympatric guild of large carnivores, wherein tigers are the apex predators followed by dhole and leopard. In this study, we attempted to understand the variation in pack size of a social carnivore, the dhole, at two neighboring sites in the Central Indian landscape. We further evaluated local-scale patterns of variation in pack size at a larger scale by doing a distribution-wide assessment across the dhole ranging countries. At the local scale, we found an inverse relationship between the density of tiger and pack size of dhole while accounting for variability in resources and habitat heterogeneity. Larger dhole packs (16.8 ± 3.1) were observed at the site where the tiger density was low (0.46/100 km^2), whereas a smaller pack size (6.4 ± 1.3) was observed in the site with high tiger density (5.36/100 km^2). Our results for the distribution-wide assessment were concordant with local-scale results, showing a negative association of pack size with the tiger densities (effect size −0.77) and a positive association with the prey abundance (effect size 0.64). The study advances our understanding to answer the age-old question of "what drives the pack size of social predators in a multipredator system?" This study also highlights the importance of understanding demographic responses of subordinate predator for varying competitor densities, often helpful in making informed decisions for conservation and management strategies such as population recovery and translocation of species.

Biswas, S. (2021). Metapopulation Dynamics of Tiger in the Terai Arc Landscape, India (Doctoral dissertation). Saurashtra University.

Lahkar, D., Ahmed, M.F., Begum, R.H., Das, S.K., and Harihar, A. 2021. Inferring patterns of sympatry among large carnivores in Manas National Park–a prey-rich habitat influenced by anthropogenic disturbances. Animal Conservation, 24(4), pp.589-601.

ABSTRACT

Inferring the mechanisms that facilitate sympatry amongst large mammalian carnivores in anthropogenically altered habitats is critical if conservation initiatives aimed to recover populations are to be effective. In this study, we assessed the utilization of space, time and prey resources by tigers Panthera tigris, leopards P. pardus and dholes Cuon alpinus in Manas National Park (MNP), India – a site where prey densities are not limiting, yet anthropogenic influences alter the spatial and temporal behaviour of prey. We use photographic capture data and predator scats collected over three sampling years (2014–15, 2015–16 and 2016–17) to assess patterns of (a) spatial use using a multispecies species occupancy framework, (b) time–activity patterns and overlap between predators and prey using non-parametric circular kernel-density functions, (c) fine-scale spatio-temporal behaviour by comparing time-to-encounters of subsequent events and (d) predator diets by analysing prey remains in predator scats. Our results highlight that the predators segregate through fine-scale spatio-temporal avoidance rather than displaying population-level changes in space-use, activity patterns or food habits. Overlap in space-use between tigers and leopards was high and time–activity patterns of the predators closely matched those of prey, suggesting that predators likely maximize resource acquisition in this prey-rich environment. Ungulate prey dominated the diet of predators, resulting in the high dietary overlap. From our results, we infer patterns of sympatry among large carnivores in the face of anthropogenic influences and highlight the need to understand interspecific interactions within a community before initiating conservation actions aimed at recovering these endangered species.

Malviya, M. (2021). Proximate Drivers of Human-Tiger Interface and Conflict in Sariska and Panna Tiger Reserves, India (Doctoral dissertation). Saurashtra University.

This study addresses the complex challenge of human-wildlife conflict, focusing on the conflict between humans and tigers in the Sariska and Panna Tiger Reserves in India. Tigers are among the large felids most prone to conflict, and such conflicts pose a threat to their conservation. The study introduces a conflict determinant model, aiming to identify socio-ecological factors influencing human-tiger conflict (HTC) and understand the conflict's mechanisms and dynamics. Both reserves experienced local tiger extinctions, making the study crucial for ongoing reintroduction efforts.

The research investigates ecological, biological, and socio-economic drivers of HTC. Ecological

factors, including prey availability, cover, water, and anthropogenic disturbance, were analyzed using various methods such as line transects, circular plots, camera traps, and GIS. Biological parameters of tigers involved in conflict, along with socio-economic factors, were studied through questionnaires and data on livestock kills. The severity of HTC was found to be higher in Sariska, attributed to higher livestock dependence and grazing pressure.

Results indicate that tigers choose areas with high wild prey and specific terrain characteristics, making livestock more vulnerable. Certain tigers, such as males and younger individuals, were more prone to conflict, and home range quality influenced livestock depredation. Socio-economic drivers revealed the importance of local community dependence on reserve forests for fodder, contributing to livestock vulnerability.

Mitigation strategies were proposed, emphasizing targeted habitat improvement in high-risk areas, especially for tigers prone to depredating livestock. Community engagement and education, particularly targeting rural women, were recommended to address negative attitudes towards tigers and improve human-wildlife relationships.

Puri, M., Srivathsa, A., Karanth, K. K., Patel, I., and Kumar, N. S. (2021). Links in a sink: Interplay between habitat structure, ecological constraints and interactions with humans can influence connectivity conservation for tigers in forest corridors. The Science of the Total Environment, 809, 151106. *http://dx.doi.org/10.1016/j.scitotenv.2021.151106*.

ABSTRACT

Global land-use changes and rapid infrastructure development necessitate identification and conservation of wildlife corridors. Connectivity through corridors is shaped by species' structural, ecological and behavioral constraints. In multi-use landscapes, species' interactions with humans could additionally influence connectivity. Using the tiger Panthera tigris as a case study, we make simultaneous assessments of potential connectivity, habitat use and examine their links with the species' negative interactions with humans in central India. We assessed potential connectivity across 10, 000 sq. km of the Kanha–Pench forest corridor using graph-theoretic methods. Combining indirect sign surveys and occupancy models, we examined habitat use, and evaluated its congruence with potential connectivity. Next, we estimated spatial probabilities of livestock depredation through application of multi-state occupancy models to interview-based survey data from local residents. Habitat use by tigers was negatively associated with forest fragmentation and anthropogenic disturbance. Livestock depredation was positively associated with size of settlements and areas most frequented by tigers, and negatively with anthropogenic disturbance within forests. We found high congruence between connectivity and habitat use (r = 0.80); but the strong correlation did not hold in areas with

very high levels of livestock depredation levels. Our results indicate that when areas of high use by tigers are constrained by limited connectivity, there are higher chances of human-tiger conflict, and these areas may be ecological traps for the species. Interactions with humans can be crucial in mediating connectivity for large carnivores in shared habitats. Our findings present an opportunity to consolidate areas where carnivore conservation and local livelihood needs can be balanced. Our framework also provides a foundation for spatial prioritization that incorporates a plurality of dimensions, with utility for connectivity conservation of other wide-ranging carnivores.

Rasal, V., Everard, M., Khandal, D., Chandrawal, K., and Sahu, Y. K. (2021). Evaluation of the ecosystem services provided by the Kailadevi Wildlife Sanctuary, Rajasthan, India. Parks, 27(1), 13-24.
https://uwe-repository.worktribe.com/output/7437881/evaluation-of-the-ecosystem-services-provided-by-the-kailadevi-wildlife-sanctuary-rajasthan-india.

ABSTRACT

Kaila devi Wildlife Sanctuary (KWLS), in Rajasthan (India), lost its Tiger population 2000. However, Tigers have recolonised since 2019 as over-spill from the adjacent Ranthambhore National Park (RNP). Though KWLS is protected, its depleted foreststsupport resident and migratory communities. A VALUE+ approach used local interviews, primary fieldwork and literature sources to determine ecosystem services provided by KWLS, where possible with monetary representation. Conservative values derived for 21 ecosystem services covered: (1) benefit flows estimated as INR84.47 billion yr-1; (2) natural capital stock of INR 367.3 billion; and (3) unquantified ecosystem services. Monetary values should be treated cautiously, as illustrative representations largely reflected by surrogate markets, though indicative of the range of mainly unappreciated benefits to society. This study is novel in addressing ecosystem service flows and values of an Indian wildlife reserve on a systemic basis supported by substantial primary fieldwork. It illuminates the many societal values flowing from the Sanctuary. These can inform compensation for KWLS users who may become displaced if the area is encompassed within an expanded RNP. The study also illustrates likely improved flows of benefits if greater protection is afforded, including potential future ecotourism and space for reestablished Tiger and other wildlife populations.

Sagar, B., Selvi, G., Agasti, S., Kari, B., Singh, H., Kumar, A., Gupta, R., and Reddy, G. 2021. The spacing pattern of reintroduced tigers in human-dominated Sariska Tiger Reserve. Journal of Wildlife and Biodiversity, 5(1), pp.1-14.

ABSTRACT

This study aimed to estimate the tiger home range size and obtain information on the movement pattern of reintroduced tigers in the human-dominated Sariska Tiger Reserve. The observed extensive home ranges (100% MCP method) of tigresses ST3 (172.75 km²), ST9 (85.25 km²), and ST10 (80.10 km²) can be attributed to low prey base and very high anthropogenic forces. Similarly, the observed small home range of tigresses ST7, ST2, ST14, and ST8 viz. 16.59 km², 19.34 km², 36.58 km², and 43.04 km² respectively is due to high prey abundance in their respective areas. The high home ranges of subadult ST13 & ST15, respectively, up to 687.58 km² and189.46 km² is due to the initial exploration of their territory. After settling in their respective territories, ST13 in North of STR and ST15 in the south, their mean monthly home ranges respectively decreased to 61.37 km² and 47.67 km². The observed larger mean home ranges (based on 100% MCP method) of ST4 (85.40 km²) and ST6 (79.94 km²) as compared to young ST13 (61.369 km²), ST11 (57.63 km²), and ST15 (47.67 km²) may be due the reason of early occupancy of the respective areas by these old tigers. Non-expansion of the home ranges of any of the remaining four male tigers (ST4, 6, 13, and 15) after the killing of ST11male tiger in STR suggests non-exploratory behavior of already settled male tigers. The observed high average monthly displacement of the home range for sub-adult ST15 can be justified regarding its dispersal from the natal area to the south of STR. Exploring the southern part of the reserve and finally settling in a smaller area with minimum displacement of monthly home ranges can be other justification as well.

Shameer, T. T., Mungi, N. A., Ramesh, B., Kumar, S. V., and Easa, P. S. (2021). How can spatio-temporal overlap in mammals assist in maximizing biodiversity conservation? A case study of Periyar Tiger Reserve. Biologia, 76(4), 1255-1265. *http://dx.doi.org/10.2478/s11756-020-00645-1*.

ABSTRACT

While global mammalian diversity is collapsing due to increased poaching and habitat loss, evidence-based conservation in protected areas is often regarded as a panacea. Tiger reserves in India set an example, where annual camera trap monitoring is conducted for understanding the trends in the tiger population. However, less is known about other co-predators and their prey species that occur in the same area. The fundamental hindrance being the absence of individual pelage pattern within these species (i.e. unique pattern on the body), as well as the absence of species-specific monitoring. As a result, there is a demand in techniques that can avail maximum biodiversity information from the existing monitoring protocols. Here, we conducted camera trapping in Periyar Tiger Reserve to evaluate spatiotemporal overlaps within different carnivores, and between prey-predators. Camera trapping was conducted at high resolution (2 km²) for 30 days at 253 locations that yielded 6092 photographs of 18 mammals. Their temporal overlap was estimated using 'overlap' R package, while the spatial association was estimated using 'co-occur' package. Three large-ranging top predators (tiger, leopard and dhole) were found to have activity peaks segregated temporally. Relationship of these predators with their prey species highlighted the role of body sizes, where largest predator (tiger) had higher overlap with large-bodied prey (gaur and sambar), while small-bodied predator (leopard and dhole) overlapped small-bodied prey (barking deer and wild pig). Results highlight the importance of large-sized prey in conserving the tiger densities of this region. However, selectively conserving only large-bodied prey can have repercussions on other sympatric carnivores, who require different body-sized prey species. Our results have implications for all protected areas in the tropical developing countries, which are mostly smaller in area with species-centered conservation agenda. We highlight the importance of considering species-specific carrying capacity of all co-predators in the region, to optimally conserve the prey-base through habitat restoration, so as to maximize biodiversity conservation within a limited area.

Singh, R., Pandey, P., Qureshi, Q., Sankar, K., Krausman, P.R., and Goyal, S.P. 2021. Philopatric and natal dispersal of tigers in a semi-arid habitat, western India. Journal of Arid Environments, 184, p.104320.

ABSTRACT

The connectivity between landscapes is an important aspect of the conservation of small and isolated populations of carnivores. We studied the natal dispersal pattern of Bengal tigers (Panthera tigris tigris) using motion-sensitive cameras and intensive searches from April 2005 to June 2011 in Ranthambhore Tiger Reserve (RTR), western India. We tracked 29 tiger cubs (18 males, 11 females) born during the study until they established independent territories. All the females and 72.2% of the males attained maturity. The males had a greater probability (92.3%) of dispersal compared with the females (36.4%). Males dispersed an average distance of 27.0 ± 12.7 (SE) km (range = 4.5–148 km), while females dispersed an average distance of 5.7 ± 3.03 km (range = 4.6–25.8 km) from their natal area to establish their independent territories. The average age of dispersal was 38.6 ± 2.6 months (range = 24–44 months) for the males and 27.7 ± 2.7 months (range = 25–33 months) for the females. Seven of the 11 females bred at >48 months' age, after establishing independent territories. Of the other females, three were translocated to another protected area, and one died after the dispersal. This study adds to the baseline information about the dispersal patterns of tigers, which is important in making conservation and management decisions for restoration of tiger populations.

Thapaa, K., Malla, S., Subba, S. A., Thapa, G. J., Lamichhane, B. R., Subedi, N., Dhakal, M., Acharya, K. P., Karki Thapa, M., Neupane, P., Poudel, S., Bhatta, S. R., Jnawali, S. R., and Kelly, M. J. (2021). On the tiger trails: Leopard occupancy decline and leopard interaction with tigers in the forested habitat across the Terai Arc Landscape of Nepal. Global Ecology and Conservation, 25, e01412.

ABSTRACT

Better conservation planning requires updated information about leopard distribution to prioritize and allocate limited resources available. The long-term persistence of leopards and sympatric tigers can be compromised by linear infrastructure development such as roads that fragment habitat. We used detection and non-detection data collected along walking search paths (~4,140 km) in 96 grid cells (each cell 15 km by 15 km) spread across potential habitat (~13,845 km²) in the Terai Arc Landscape, Nepal. Multi-season occupancy models allowed us to make both spatial and temporal inferences between two surveys in 2009 and 2013, based on ecologically relevant covariates recorded in the field or remotely sensed. Additionally, we used 2013 data to make inferences on co-occurrence between tigers and leopards at the landscape level. We found the additive model containing deforestation and district roads negatively influenced leopard detection across the landscape. Although weak, we found anthropogenic factors such as extent of deforestation (decrease in forest cover) negatively affected leopard occupancy. Road abundance, especially for the east-west highway and district roads, also negatively (but weakly) influenced leopard occupancy. We found substantially lower occupancy in the year 2013 (0.59 (SE 0.06) than in 2009 (0.86 (SE 0.04)). Tigers and leopards co-occurred across the landscape based on the species interaction factor (SIF) estimated at 1.47 (0.13) but the amount of available habitat and the prey index mediated co-occurrence. The SIF decreased as habitat availability increased, reaching independence at large habitat patches, but leopard occupancy declined in sites with tigers, primarily in large patches. The prey index was substantially lower outside of protected areas and leopards and tigers co-occurred more strongly in small patches and at low prey indices, indicating potential attraction to the same areas when prey is scarce. Mitigation measures should focus on preventing loss of critical leopard, tiger, and prey habitat through appropriate wildlife-friendly underpasses and avoiding such habitat when building infrastructure. Leopard conservation has received lower priority than tigers, but our metrics show a large decline in leopard occupancy, thus conservation planning to reverse this decline should focus on measures to facilitate human-leopard coexistence to ensure leopard persistence across the landscape.

Vernes, K., Rajaratnam, R., and Dorji, S. (2021). Patterns of species co-occurrence in a diverse Eastern Himalayan montane carnivore community. Mammal Research, 67(2), 139-149. *http://dx.doi.org/10.1007/s13364-021-00605-3*.

ABSTRACT

We investigated patterns of species richness and co-occurrence in a montane carnivore community within a forested landscape in Bhutan that ranged in altitude from 2000 to 3760 m above sea level, and covered an area of approximately 140 km². Species were detected by unbaited camera traps set along animal trails and baited camera traps set away from trails. During the 6-month study, we gathered 1,329 independent mammal events from 67 camera-trap locations, of which, 145 (10.9%) were of 13 different carnivore species from five different families. Four carnivores were IUCN red-listed threatened species: tiger (Panthera tigris), marbled cat (Pardofelis marmorata), dhole (Cuon alpinus), and Asiatic black bear (Ursus thibetanus). For most camera stations where carnivores were detected, only a single carnivore species was captured on camera and there was evidence of temporal partitioning of activity between large (tiger and leopard, Panthera pardus) and small (marbled cat, golden cat Catopuma temminckii, and leopard cat Prionailurus bengalensis) felids, and between two common mustelids, the Siberian weasel (Mustela sibirica) and yellow-throated marten (Martes flavigula). Furthermore, we detected significant non-random spatial co-occurrence for most pairwise comparisons of carnivores despite the short timeframe of our study. This, combined with temporal patterns in activity, facilitates localized species co-occurrence in a diverse montane carnivore community.

Movement Ecology

Habib, B., Ghaskadbi, P., Khan, S., Hussain, Z., and Nigam, P. (2021). Not a cakewalk: Insights into movement of large carnivores in human-dominated landscapes in India. Ecology and Evolution, 11(4), 1653-1666. *http://dx.doi.org/10.1002/ece3.7156*

ABSTRACT

Large carnivores play an important role in the functioning of ecosystems, yet their conservation remains a massive challenge across the world. Owing to wide-ranging habits, they encounter various anthropogenic pressures, affecting their movement in different landscape. Therefore, studying how large carnivores adapt their movement to dynamic landscape conditions is vital for management and conservation policy. A total of 26 individuals across 4 species of large carnivores of different sex and age classes (14 Panthera tigris, 3 Panthera pardus, 5 Cuon alpinus, and 4 Canis lupus pallipes) were GPS collared and monitored from 2014–19. We quantified movement parameters (step length and net squared displacement) of four large carnivores in and outside protected areas in India. We tested the effects of human pressures such as human density, road network, and landuse types on the movement of the species. We also examined the configuration of core areas as a strategy to subsist in a human-dominated landscape using BBMM. Mean displacement of large carnivores varied from 99.35

m/hr for leopards to 637.7 m/hr for wolves. Tigers outside PAs exhibited higher displacement than tigers inside PAs. Moreover, displacement during day–night was significantly different for tigers inside and outside PAs. Similarly, wolf also showed significant difference between day-night movement. However, no difference in day–night movement was found for leopard and dholes. Anthropogenic factors such as road length and proportion of agriculture within the home range of tigers outside PAs were found to be significantly different. All the habitat variables in the home range showed significant difference between the social canids. The core area size for tiger outside PA and wolf was found greater than PAs. The study on movement of large carnivore species across landscapes is crucial for conservation planning. Our findings can be a starting point for interlinking animal movement and landscape management of large carnivore conservation in the current Anthropocene.

Sarkar, M. S., Niyogi, R., Masih, R. L., Hazra, P., Maiorano, L., and John, R. (2021). Long-distance dispersal and home range establishment by a female sub-adult tiger (Panthera tigris) in the Panna landscape, central India. European Journal of Wildlife Research, 67(3), 1-7.
http://dx.doi.org/10.1007/s10344-021-01494-2

ABSTRACT

Dispersal from one population to another is crucial for meta-population stability and survival. Long-distance dispersal events have been widely documented in male tigers (Panthera tigris), but similar events in female tigers are less known. We opportunistically recorded a long-distance dispersal event that ended with the establishment of a new home-range for a radio-collared sub-adult female tiger in central India. We analysed the animal's movement patterns during the dispersal event and the subsequent home-range establishment. The average minimum distance and the average minimum daily displacements were 11.4 km and 4.5 km respectively. The total linear and cumulative displacements were 99.1 km and 340.2 km respectively, undertaken over 78 days. Using a Brownian bridge movement model, we showed that the tiger was not moving in a linear path, but showed exploratory movement. During this dispersal event, the tiger traversed an area of 2082 km^2 (95% UD), including 19 distinct 'stepping-stone' habitat patches. Combining the Ornstein–Uhlenbeck movement behaviour model and an autocorrelated kernel density estimation model, we identified a newly established home range of 40.3 km^2 at the end of the dispersal event. Our results describe the longest known female tiger dispersal event, highlighting the possibility that natural dispersal of female tigers can provide an additional option to assisted translocations for the species range expansion. This is relevant in current scenarios where tiger habitats remain fragmented and tiger population numbers are recovering due to effective in situ conservation efforts.

GENETICS AND FORENSIC

Chakraborty, C., Sharma, A. R., Sharma, G., Bhattacharya, M., Patra, B. C., Sarkar, B. K., Banerjee, S., Banerjee, K., and Lee, S. S. (2021). Understanding the molecular evolution of tiger diversity through DNA barcoding marker ND4 and NADH dehydrogenase complex using computational biology. Genes and Genomics, 43(7), 759-773.
http://dx.doi.org/10.1007/s13258-021-01089-w

Background: Currently, Tigers (the top predator of an ecosystem) are on the list of endangered species. Thus the need is to understand the tiger's population genomics to design their conservation strategies.

Objective: We analyzed the molecular evolution of tiger diversity using NADH dehydrogenase subunit 4 (ND4), a significant electron transport chain component.

Methods: We have analyzed nucleotide composition and distribution pattern of ND genes, molecular evolution, evolutionary conservation pattern and conserved blocks of NADH, phylogenomics of ND4, and estimating species divergence, etc., using different bioinformatics tools and software, and MATLAB programming and computing environment.

Results: The nucleotide composition and distribution pattern of ND genes in the tiger genome demonstrated an increase in the number of adenine (A) and a lower trend of A+T content in some place of the distribution analysis. However, the observed distributions were not significant ($P > 0.05$). Evolutionary conservation analysis showed three highly align blocks (186 to 198, 406 to 416, and 527 to 545). On mapping the molecular evolution of ND4 among model species ($n = 30$), we observed its presence in a broader range of species. ND4 based molecular evolution of tiger diversity and time divergence for a tiger (20 different other species) shows that genus Panthera originated more or less at a similar time.

Conclusions: The nucleotide composition and nucleotide distribution pattern of tiger ND genes showed the evolutionary pattern and origin of tiger and Panthera lineage concerning the molecular clock, which will help to understand their adaptive evolution.

Khan, A., Patel, K., Shukla, H., Viswanathan, A., van der Valk, T., Borthakur, U., Nigam, P., Zachariah, A., Jhala, Y.V., Kardos, M., and Ramakrishnan, U. 2021. Genomic evidence for inbreeding depression and purging of deleterious genetic variation in Indian tigers. Proceedings of the National Academy of Sciences, 118(49), p.e2023018118.

ABSTRACT

Increasing habitat fragmentation leads to wild populations becoming small, isolated, and threatened by inbreeding depression. However, small populations may be able to purge recessive deleterious alleles as they become expressed in homozygotes, thus reducing inbreeding depression and increasing population viability. We used whole-genome sequences from 57 tigers to estimate individual inbreeding and mutation load in a small–isolated and two large–connected populations in India. As expected, the small–isolated population had substantially higher average genomic inbreeding (FROH = 0.57) than the large–connected (FROH = 0.35 and FROH = 0.46) populations. The small–isolated population had the lowest loss-of-function mutation load, likely due to purging of highly deleterious recessive mutations. The large populations had lower missense mutation loads than the small–isolated population, but were not identical, possibly due to different demographic histories. While the number of the loss-of-function alleles in the small–isolated population was lower, these alleles were at higher frequencies and homozygosity than in the large populations. Together, our data and analyses provide evidence of 1) high mutation load, 2) purging, and 3) the highest predicted inbreeding depression, despite purging, in the small–isolated population. Frequency distributions of damaging and neutral alleles uncover genomic evidence that purifying selection has removed part of the mutation load across Indian tiger populations. These results provide genomic evidence for purifying selection in both small and large populations, but also suggest that the remaining deleterious alleles may have inbreeding-associated fitness costs. We suggest that genetic rescue from sources selected based on genome-wide differentiation could offset any possible impacts of inbreeding depression.

Khan, A., Krishna, S. M., Ramakrishnan, U., and Das, R. (2021). Recapitulating whole genome-based population genetic structure for Indian wild tigers through an ancestry informative marker panel. Heredity, 128(2), 1-9. *http://dx.doi.org/10.1038/s41437-021-00477-y*

ASBTRACT

Identification of genetic structure within wildlife populations have implications in their conservation and management. Accurately inferring population genetic structure requires whole-genome data across the geographical range of the species, which can be resource-intensive. A cheaper strategy is to employ a subset of markers that can efficiently recapitulate the population genetic structure inferred by the whole genome data. Such ancestry informative markers (AIMs), have rarely been developed for endangered species such as tigers utilizing single nucleotide polymorphisms (SNPs). Here, we first identify the population structure of the Indian tiger using whole-genome sequences and then develop an AIMs panel with a minimum number of SNPs that can recapitulate this structure. We identified four population clusters

of Indian tigers with North-East, North-West, and South Indian tigers forming three separate groups, and Terai and Central Indian tigers forming a single cluster. To evaluate the robustness of our AIMs, we applied it to a separate dataset of tigers from across India. Out of 92 SNPs present in our AIMs panel, 49 were present in the new dataset. These 49 SNPs were sufficient to recapitulate the population genetic structure obtained from the whole genome data. To the best of our knowledge, this is the first-ever SNP-based AIMs panel for big cats, which can be used as a cost-effective alternative to whole-genome sequencing for detecting the biogeographical origin of Indian tigers. Our study can be used as a guideline for developing an AIMs panel for the management of other endangered species where obtaining whole genome sequences are difficult.

Nittu, G., Bhavana, P. M., Shameer, T. T., Ramakrishnan, B., Archana, R., Kaushal, K. K., Khedkar, G., Mohan, G., Jyothi, M., and Sanil, R. (2021). Simple Nested Allele-Specific approach with penultimate mismatch for precise species and sex identification of tiger and leopard. Molecular Biology Reports, 48(2), 1667-1676. *http://dx.doi.org/10.1007/s11033-021-06139-w*

ABSTRACT

Accurate species and sex identification of non-invasive and forensic samples of the tiger and leopard is still confusing when using the allele-specific methods. We designed allele-specific methods with penultimate nucleotide mismatch in a nested manner for the exact identification and double-checking of forensic samples. The mismatch design is a novel concept in species and sex identification, making the allele-specific targeting precise. We developed three sets of markers, a 365 bp outer and a 98 bp inner marker for nested tiger species identification assay, 136 bp leopard specific marker, and carnivore sex identification markers. We validated the method with tissue/blood forensic samples of various felids and herbivorous available in our lab and on known fecal samples from Vandalur Zoo. We also collected 37 scat samples at diverse stages of deterioration from the Mudumalai Tiger Reserve, Tamil Nadu, India. The 365 bp targeted markers resulted in 70.2% (n = 22; 22/37) amplification success, while the 98 bp FAM-labelled marker amplified 89% (n = 33; 33/37) scat samples independently. The 136 bp leopard markers answered four scat samples (11%) unrequited by the tiger specific markers. We evaluated species and the sex identification with these markers in another 190 non-invasive samples provided by the Mudumalai Tiger Reserve authorities. Among which 56.3% (n = 107) of samples were recognized as tiger (64 male and 43 female) and 38.9% (n = 74) as leopard (41 male and 33 female). The method supersedes any other previous methods in this regard by its high accuracy and simplicity.

Patel, S. K., Biswas, S., Goswami, S., Bhatt, S., Pandav, B., and Mondol, S. (2021). Effects of faecal inorganic content variability on quantifying glucocorticoid and thyroid hormone metabolites in large felines: Implications for physiological assessments in free-ranging animals. General and Comparative Endocrinology, 310, 113833-113833.
http://dx.doi.org/10.1016/j.ygcen.2021.113833

ABSTRACT

Faecal glucocorticoid (GC) and triiodothyronine (T3) metabolites and their interactions are increasingly used to monitor perceived stress and nutritional challenges in free-ranging animals. However, a number of extrinsic and intrinsic factors including hormone-inert dietary materials, inorganic matters etc. are known to affect reliable hormone metabolite quantifications. In this study, the impacts of inorganic matter (IOM) on faecal GC (fGCMs) and T3 (fT3Ms) metabolite measure were addressed in wild tiger (n = 193 from Terai Arc landscape, India) and captive lion (n = 120 from Sakkarbaug Zoological Garden, Gujarat, India) and possible corrective measures were evaluated. The wild tiger samples contained highly variable IOM content (9–98%, mostly with > 40% IOM) compared to captive Asiatic lion (17–57%, majority with < 40% IOM). Significant correlations were observed between IOM content and tiger fGCM (r = -0.46, p = 0.000), fT3M (r = -0.58, p = 0.000) and lion fT3M measures (r = -0.43, p = 0.003). Two corrective measures viz. removing samples with ≥ 80% IOM and subsequently expressing concentrations as per gram of organic dry matter (instead of total dry matter) reduced IOM influence on tiger fGCM, fT3M and lion fT3M, without affecting lion fGCM measures. The corrective measures changed the interpretations of fT3M data of field-collected tiger samples with no significant changes in fGCM (both tiger and lion) and fT3M (lion) data. As faecal IOM content is common in many wild species, the results emphasize the need to reduce IOM-driven hormone data variation for ecologically relevant interpretations towards species conservation.

Roy, J., Singh, A., Rohith, M. M., Sharma, L. K., Johnson, A., Joshi, H., Chinnadurai, V., Chandra, K., and Thakur, M. (2021). Cranio-dental signature of three big cats of India: Implications in wildlife forensics. Proceedings of the Zoological Society, 75(1), 57-64.
http://dx.doi.org/10.1007/s12595-021-00390-6

ABSTRACT

Identifying species from various confiscated material is a prerequisite and of utmost importance to extend support to the law enforcement agencies in curbing illegal wildlife trade and prosecution of the cases in the court of law. Cranio and odontometric measurements have been used in developing characters for ascertaining species identity from the osteological specimens. In the present study, we established baseline data by measuring the cranial and odontometric variables in differentiating the skulls of three big cats of India, i.e. tiger, leopard and lion. The skulls of tigers were the largest and weighed heaviest among three felids and the lateral profiles revealed very sharp maxilla-naso-frontal suture angle. The skulls of lions were relatively intermediate in size having obtuse maxilla-naso-frontal suture angle with relatively rounded appearance. Leopard skulls were smallest having a prominent canine grooves and convex nasal profiles. The multivariate, principal component analysis using the selected cranio-mandibular measurement data successfully differentiated the three species. The findings of the present study will aid in forensic identification of the confiscated cranium/parts or tooth of these three big cats and open new avenues to examine the museum specimens with the reported cranio-mandibular measurements.

Sagar, V., Kaelin, C. B., Natesh, M., Reddy, P. A., Mohapatra, R. K., Chhattani, H., Thatte, P., Vaidyanathan, S., Biswas, S., Bhatt, S., Paul, S., Jhala, Y. V., Verma, M. M., Pandav, B., Mondol, S., Barsh, G. S., Swain, D., and Ramakrishnan, U. (2021). High frequency of an otherwise rare phenotype in a small and isolated tiger population. Proceedings of the National Academy of Sciences of the United States of America, 118(39). *http://dx.doi.org/10.1073/pnas.2025273118*.

ABSTRACT

Most endangered species exist today in small populations, many of which are isolated. Evolution in such populations is largely governed by genetic drift. Empirical evidence for drift affecting striking phenotypes based on substantial genetic data are rare. Approximately 37% of tigers (Panthera tigris) in the Similipal Tiger Reserve (in eastern India) are pseudomelanistic, characterized by wide, merged stripes. Camera trap data across the tiger range revealed the presence of pseudomelanistic tigers only in Similipal. We investigated the genetic basis for pseudomelanism and examined the role of drift in driving this phenotype's frequency. Whole-genome data and pedigree-based association analyses from captive tigers revealed that pseudomelanism cosegregates with a conserved and functionally important coding alteration in Transmembrane Aminopeptidase Q (Taqpep), a gene responsible for similar traits in other felid species. Noninvasive sampling of tigers revealed a high frequency of the Taqpep p.H454Y mutation in Similipal (12 individuals, allele frequency = 0.58) and absence from all other tiger populations (395 individuals). Population genetic analyses confirmed few (minimal number) tigers in Similipal, and its genetic isolation, with poor geneflow. Pairwise FST (0.33) at the mutation site was high but not an outlier. Similipal tigers had low diversity at 81 single nucleotide polymorphisms (mean heterozygosity = 0.28, SD = 0.27). Simulations were consistent with founding events and drift as possible drivers for the observed stark difference of allele frequency. Our results highlight the role of stochastic processes in the evolution of rare phenotypes. We highlight an unusual evolutionary trajectory in a small and isolated population of an endangered species.

MONITORING AND ASSESSMENT

Ahmed, T., Bargali, H. S., Verma, N., and Khan, A. (2021). Mammals Outside Protected Areas: Status and Response to Anthropogenic Disturbance in Western Terai-Arc Landscape. Proceedings of the Zoological Society, 74(2), 163-170.
http://dx.doi.org/10.1007/s12595-020-00360-4

ABSTRACT

We assessed the status and distribution of mammals using camera traps in Ramnagar Forest Division between February and June 2017. A total of 2656 independent photographs representing herbivores (57.2%), carnivores (7%), omnivores (6.8%), birds (2.0%), cattle (5.6%), humans (18.7%) and free-ranging stray dogs (2.7%) were recorded from 96 trap stations. Tiger (Panthera tigris) was trapped more often than other carnivores. Spotted deer (Axis axis) stood first among the herbivores and rhesus macaque (Macaca mulatta) among the omnivores. The Relative Abundance Index (RAI) for spotted deer was highest at low anthropogenic disturbance sites, while for other members of cervidae (barking deer Muntiacus muntjac; sambar Rusa unicolor and Himalayan goral Naemorhedus goral), it was highest at sites free from the disturbance. Tiger was most abundant at low while leopard (Panthera pardus) at high anthropogenic disturbance sites. Except for leopard cat (Prionailurus bengalensis), other small carnivores including Jungle cat (Felis chaus), small Indian civet (Viverricula indica) and yellow-throated marten (Martes flavigula) and omnivore; golden jackal (Canis aureus) was photo captured mostly at medium human anthropogenic disturbance sites. The current information is expected to help in the formulation of management strategies for long-term conservation of mammals outside the protected areas in Terai-Arc Landscape.

Chakraborty, P., Borah, J., Bora, P. J., Dey, S., Sharma, T., Lalthanpuia, N., and Rongphar, S. (2021). Camera trap based monitoring of a key wildlife corridor reveals opportunities and challenges for large mammal conservation in Assam, India. Tropical Ecology, 62(2), 186-196.
http://dx.doi.org/10.1007/s42965-020-00138-x

ABSTRACT

To assess the corridor's functionality and prioritize protection of one of the corridors connecting Kaziranga National Park and the forests of Karbi Anglong District in Assam, India, we conducted a camera-trap study from 2011 to 2016. A total of 10,895 trap nights revealed 39 mammal and avian species, several of which were new records for the area. Relative Abundance Index was calculated as a measure of photo-capture rates from the photographic events, and annual trend for selected species and seasonal trend for elephants were analyzed. The indices showed that elephants used the corridor patch most frequently (RAI = 8.81), followed by hog deer (RAI = 2.77), while hog badgers were most rarely recorded (RAI = 0.02). Seasonality of the movement pattern of elephants showed increased use during the monsoon season. Records of nine individual tigers and six individual leopards, along with other rare and endangered species indicate functionality and regular use of the critical corridor by wildlife, crossing over between Kaziranga and Karbi Anglong hills, maneuvering through the busy National Highway—37 that cuts across the historically connected landscape. The results obtained from the study can be used to prepare a conservation action strategy to secure the corridor for safe passage of wildlife.

Jhala, Y. V., Qureshi, Q., & Yadav, S. P. (2021). Status of leopards, co-predators, and megaherbivores in India, 2018. National Tiger Conservation Authority, Government of India, New Delhi, and Wildlife Institute of India, Dehradun. ISBN - 81-85496-56-0.

SUMMARY

The report assesses the status of various wildlife species in tiger habitats across 20 Indian states, focusing on leopards, sloth bears, smaller felids, wild canids, megaherbivores, and mustelids. Using camera trap data and occupancy surveys conducted in 2018-19, the study employs a spatially explicit capture-recapture framework to estimate occupancy, relative abundance, and ecological correlates of species occurrences. The report aims to provide a large-scale baseline for monitoring population trends and initiating conservation actions, offering valuable insights for wildlife biologists, managers, and policymakers to enhance the conservation of India's diverse wildlife.

Mishra, A. K., Sarup, J., and Gupta, D. C. (2021). Geo spatial approach for tiger habitat suitability mapping: A case study of Bandhavgarh national park, Madhya Pradesh, India. International Journal of Geography, Geology and Environment, 3(2), 1-7.
http://dx.doi.org/10.22271/27067483.2021.v3.i2a.53.

ABSTRACT

In the present study, evaluation of Tiger (Panthera tigris tigris) as well as their Prey species (Chital and Sambar) habitat was carried out in AABR by using remote sensing, ground and other ancillary data, and these data sources was integrated with GIS using multi-criteria analysis (MCA) model. For the modeling, several variables in the dataset viz., forest cover type, forest cover density, slope, aspect, altitude, road, water body, settlement and drainage were used as independent variables in the analysis. All these data sets were considered as input data for developing the model. Expert views and field experience were considered while allotting values

to variables for MCA analysis to generate final weight. The results indicated that Sal, mixed Sal, miscellaneous forest, plantation, grassland, agriculture and scrub land are the major land use/land cover types and majority of the study area is covered under dense forest. The habitat parameters have tremendous impact over the habitat utilization and suitability pattern of Tiger, Chital and Sambar in AABR. From this study most suitable habitat for Tiger in AABR is 1290 km² which is 34 % of the total geographical area of the biosphere while 1077 sq. km. area comes under moderately suitable for tiger which is 28 % of the total geographical area of the biosphere. The results pointed out that 62 % of AABR has been found to be high to moderately suitable for Tiger habitat, 77% for Chital habitat and 67 % area for Sambar habitat. The results have been found to be an important input as baseline information for population modeling and natural resource management in the biosphere reserves.

Nair, A. K., Raut, M. B., Ashraf, M., and Thanekar, R. (2021). Collection and Distribution of Mahua (Madhuca longifolia), Tendu (Diospyros melanoxylon) and other NTFP's in Critical Tiger Connectivity Corridor of Maharashtra. Indian Forester, 147(4), 374-374.
http://dx.doi.org/10.36808/if/2021/v147i4/151892

ABSTRACT

Vidarbha Tiger Landscape in Maharashtra is an important Tiger Panthera tigris tigris connectivity linkage between Central India Tiger Conservation Landscape. The Nagzira Nawegaon Brahmapuri landscape acts as sinks for the Tiger source populations between Tadoba, Pench and Kanha Tiger Reserves from North to South and Vice Versa. These corridors are inhabited with several villages, dependent on the forest resources for subsistence and supplementary income. The major source of supplementary income post agriculture period for villages are collection of Tendu (Diospyros melanoxylon), Mahua (Madhuca longifolia) and other Non-Timber Forest Produces, also the trigger points for human wildlife conflict. Several programmes on reducing dependence on forest resources are implemented in these connectivity corridors by government agencies and Non-Government Organizations. This study from Vidarbha Landscape, first time documents collection and distribution of two of the most collected and other selective NTFP tree species in village common and agriculture areas, between the two Tiger connectivity corridors; Nagzira Nawegaon Tiger Reserve and Brahmapuri Forest Division near Tadoba Andhari Tiger Reserve in Maharashtra. The findings of study indicate marginal landholders and landless more dependent on collection of these resources. The findings of the study contribute towards developing inclusive corridor and conflict management plan for both the regions.

Jhala, Y.V., Qureshi, Q., & Gopal, R. (2021). Field Guide: Monitoring tigers, co-predators, prey and their habitats (5th ed.). Technical Publication of National Tiger Conservation Authority, New Delhi and the Wildlife Institute of India, Dehradun.

SUMMARY

The fifth edition of this field guide aims to provide standardized protocols for data collection, specifically designed for frontline staff and officers of forest departments. Building on the experience of the previous editions and incorporating digital data entry through mobile apps in MSTrIPES (Monitoring System for Tigers - Intensive Protection and Ecological Status), the guide emphasizes the importance of regularly monitoring source populations, suggesting a bi-annual approach for Tiger Reserves and Protected Areas. The guide outlines protocols for carnivore occupancy, prey abundance, human impacts on habitat, and habitat status. Mandatory use of M-STrIPES mobile applications, along with GPS, Range Finder, and Compass, is highlighted for error-free data collection. The guide serves as a comprehensive resource for wildlife managers, providing reliable information on carnivore species occupancy, prey abundance, human impacts, and habitat status. The accompanying MSTrIPES tools facilitate data analysis and local management decision-making.

Rather, T. A., Kumar, S., and Khan, J. A. (2021). Density Estimation of Tiger and Leopard Using Spatially Explicit Capture-Recapture Framework. PeerJ, 9, e10634.
http://dx.doi.org/10.7717/peerj.10634

ABSTRACT

The conservation of large carnivores often requires precise and accurate estimates of their populations. Being cryptic and occurring at low population densities, obtaining an unbiased population estimate is difficult in large carnivores. To overcome the uncertainties in the conventional capture-recapture (CR) methods used to estimate large carnivore densities, more robust methods such as spatially explicit capture-recapture (SECR) framework are now widely used. We modeled the CR data of tiger (Panthera tigris tigris) and leopard (Panthera pardus fusca) in the SECR framework with biotic and abiotic covariates likely believed to influence their densities. An effort of 2,211 trap nights resulted in the capture of 33 and 38 individual tigers and leopards. A total of 95 and 74 detections of tigers and leopards were achieved using 35 pairs of camera traps. Tiger and leopard density were estimated at 4.71 ± 1.20 (3.05-5.11) and 3.03 ± 0.78 (1.85-4.99) per 100 km 2. Our results show that leopard density increased with high road density, high terrain ruggedness, and habitats with a high percentage of cropland and natural vegetation. The tiger density was positively influenced by the mosaic of cropland and natural vegetation. This study provides the first robust density estimates of tiger and leopard

within the study area. Our results support the notion that large carnivores can attain moderate densities within human-dominated regions around protected areas relying on domestic livestock. Broader management strategies aimed at maintaining wild prey in the human-dominated areas around protected areas are necessary for large and endangered carnivores' sustenance in the buffer zones around protected areas.

Sabu, M. M., Pasha, S. V., Reddy, C. S., Singh, R., and Jaishanker, R. (2021). The Effectiveness of Tiger Conservation Landscapes in Decreasing Deforestation in South Asia: A Remote Sensing-Based Study. Spatial Information Research, 30(1), 63-75.
http://dx.doi.org/10.1007/s41324-021-00411-8

ABSTRACT

The alarming loss of tiger (Panthera tigris) populations due to degrading habitat called for an international commitment to double the wild tiger population by 2022 ("Tx2" goal). In the present study, eighteen Priority Tiger Conservation Landscapes (PTCLs) distributed in India, Bangladesh, Bhutan, Nepal and Myanmar were identified to investigate the trends in deforestation and fragmentation in core forest area. We used multi-decadal remote sensing-based maps to assess the rate of deforestation from 1975 to 2016. The time-series analysis revealed that there is a low to moderate level of deforestation reported in PTCLs from 1975 to 2016. The Northern Forest Complex-Namdapha-Royal Manas and Tenasserims are the geographically larger landscapes of the eighteen PTCLs that show the relatively high annual rate of deforestation from 2005 to 2016 due to the practice of shifting cultivation. The Mann Kendall trend test has indicated a statistically significant decreasing trend in deforestation across the 18 PTCLs. Overall, a low level of forest fragmentation was found in core forest habitat in the landscapes from 1995 to 2016. The results indicate management has been effective in minimizing habitat loss. The study outcomes would lead to a holistic understanding at the landscape level for long-term conservation planning in PTCLs.

Tanwar, K. S., Sadhu, A., and Jhala, Y. V. (2021). Camera Trap Placement for Evaluating Species Richness, Abundance, and Activity. Scientific Reports, 11(1), 23050.
http://dx.doi.org/10.1038/s41598-021-02459-w

ABSTRACT

Information from camera traps is used for inferences on species presence, richness, abundance, demography, and activity. Camera trap placement design is likely to influence these parameter estimates. Herein we simultaneously generate and compare estimates obtained from camera traps (a) placed to optimize large carnivore captures and (b) random placement, to infer

accuracy and biases for parameter estimates. Both setups recorded 25 species when same number of trail and random cameras (n = 31) were compared. However, species accumulation rate was faster with trail cameras. Relative abundance indices (RAI) from random cameras surrogated abundance estimated from capture-mark-recapture and distance sampling, while RAI were biased higher for carnivores from trail cameras. Group size of wild-ungulates obtained from both camera setups were comparable. Random cameras detected nocturnal activities of wild ungulates in contrast to mostly diurnal activities observed from trail cameras. Our results show that trail and random camera setup give similar estimates of species richness and group size, but differ for estimates of relative abundance and activity patterns. Therefore, inferences made from each of these camera trap designs on the above parameters need to be viewed within this context.

SUSTAINABLE SOLUTIONS AND TECHNOLOGY

Kishore, T. E., Jha, A., Kumar, S., Bhattacharya, S., and Sultana, M. (2021). Deep CNN Based Automatic Detection and Identification of Bengal Tigers. In P. Dutta, J. K. Mandal, and S. Mukhopadhyay (Eds.), Computational Intelligence in Communications and Business Analytics. CICBA 2021. Communications in Computer and Information Science, 1406. Springer.
https://doi.org/10.1007/978-3-030-75529-4_15

ABSTRACT

A system for individual identification of The Royal Bengal Tigers (Panthera tigris) is absolutely necessary not only for monitoring the population of tigers but also for saving the precious lives of those workers whose job is to count the exact number of tigers present in a particular region like Sundarban in West Bengal, India. In this paper, a solution has been proposed for individual identification of Bengal Tigers using an autonomous/manually controlled drone. In the proposed system, the drone camera will search for the tigers using a Tiger Detection Model and then the flank (the body part which contains the stripes) of the detected tiger will be passed through a Fine-tuned state-of-art network. The system based on deep CNN will detect the uncommon features for individual counting of the tiger in a particular forest. The proposed system will enhance the accuracy of tiger detection technique that will be followed by the human experts. It also reduces the risk of accidents relating to animal attacks.

Chatterjee, N., Schuttler, S. G., Nigam, P., & Habib, B. (2021). Deciphering the rarity-detectability continuum: optimizing survey design for terrestrial mammalian community. Ecosphere, 12(9), e03748. *https://doi.org/10.1002/ecs2.3748*

ABSTRACT

Wildlife monitoring is of fundamental importance to establish baseline information, measure population changes, and extinction risk. Motion-triggered camera traps are an increasingly popular tool for monitoring terrestrial species over large landscapes. Over the years, occupancy has become a robust and unbiased state variable to monitor species worldwide. However, the optimal sampling design required for robust estimations of occupancy is lacking for many species. Here, we estimated the optimum sampling design by varying the number of sites (50–400) and sampling days (10–25) for a range of mammal species using camera-trap survey data from central India. We used power analysis and mean-squared error and evaluated the hypothesis of how various species-specific traits influence occupancy and detectability of the species. We found that mean-squared error changed significantly with the number of sampling sites for rare species, whereas for species with moderate and high detection probability, the mean-squared error changed significantly with the number of sampling occasions. Power increased with an increase in the number of sampling sites and occasions for all species, although the change was not significant for species with higher occupancies or detection probabilities. We found that body size was positively related to occupancy but did not influence detection probability significantly. No relationship was detected with social status or diet on occupancy or detection probability. Our results suggest a minimum of 50 sites for 15–20 d for common species and 100 sites for 20–30 d for rare, elusive species. Our results provide guidelines to managers and practitioners for effective allocation of cost and sampling effort for a wide variety of terrestrial mammals in camera-trap surveys.

ZOOLOGY AND ANIMAL WELFARE

Jepsen, E. M., Scheun, J., Dehnhard, M., Kumar, V., Umapathy, G., and Ganswindt, A. (2021). Non-invasive monitoring of glucocorticoid metabolite concentrations in native Indian, as well as captive and re-wilded tigers in South Africa. General and Comparative Endocrinology, 308, 113783. http://dx.doi.org/10.1016/j.ygcen.2021.113783.

ABSTRACT

Over the last century, wild tiger (Panthera tigris) numbers have declined from over 100 000 individuals to fewer than 4 000, with animals now confined to less than 5% of their historic range due to habitat loss, persecution, inadequate management, and poaching. In contrast, 15 000-20 000 tigers are estimated to be housed in captivity, experiencing conditions vastly different than their wild counterparts. A total of 280 tigers are currently held at 44 different facilities within South Africa, including zoos, semi-captive 're-wilded' populations, and pets; these animals provide a unique opportunity to measure the impact of extrinsic factors, found in exotic habitats, on the adrenocortical activity of tigers. By monitoring and comparing stress-related faecal glucocorticoid metabolite (fGCM) concentrations of tigers housed at different locations, and free ranging tigers in natural tiger reserves, this project aimed to get a better understanding of the impact of extrinsic factors on adrenocortical function as a measure of stress. The results of this study showed no significant difference in fGCM concentrations between captive, re-wilded, and free-ranging tigers with the exception of one site. Furthermore, factors such as sex and season were not significant drivers of fGCM concentrations. One study group had elevated fGCM concentrations, showing population variation in the stress response. This indicates that populations are able to cope with exotic environments, however, as population-specific differences in the stress response exist, we suggest management protocols be created for each population. This study offered the unique opportunity to see how well tigers are faring outside of their native range and if having re-wilded tigers in exotic locations is a potential welfare-acceptable management option for tiger conservation globally.

Sharma, V., Sharma, C. P., Sharma, V., Goyal, S. P., and Gupta, S. K. (2021). Fast and cost-effective age estimation in Bengal tiger and Asiatic lion: Applicability of cementum analysis method. bioRxiv. http://dx.doi.org/10.1101/2021.09.27.461978.

ABSTRACT

Age estimation methods, through cementum analysis, for wild animals are rarely developed in Southeast Asian Countries. In the present study, we describe the applicability of the cementum analysis technique for developing a fast (plus minus 1, 19 hours) and cost-effective age estimation method for Bengal tiger (Panthera tigris tigris) and Asiatic lion (Panthera leo persica) using incisor tooth. The I2 and I3 incisor teeth from the right mandible of a tiger and I2 and I3 from the left maxilla of a lion were used in the study. The longitudinal sections of the tooth were made using a low cost hand grinding technique on sand papers followed by decalcification and staining with hematoxylin. The cementum layers were counted under the microscope at 100X or 200X magnifications. Two cementum layers were observed in each of the I2 and I3 incisor tooth of tiger and six cementum layers were observed in each of the I2 and I3 incisor teeth of lion. The permanent incisors in tiger and lion erupt between 12-14 months; hence, we added 1 year to the counted number of cementum layers to estimate the final age of tiger and lion incisors. The absolute age of tiger and lion incisors was estimated to be of 2+1 years and 6+1 years, respectively. The same number of cementum layers in both incisors respective to the tiger and lion were observed. Therefore, we suggest (i) undertake the blind test and (ii) collect incisor teeth from naturally died or killed individuals for strengthening the database on the age of the wild population. This optimized method may be suitable for many carnivore species, applicable in wildlife forensic studies and can be used by researchers with minimum expertise, time, and funds requirements throughout the world.

INDONESIA

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Behaviour

Khalis, M. A., Ar Rasyid, U. H., and Rahmi, E. (2021). Daily Behavior of Sumatran Tigers (Panthera Tigris Sumatrae) in Kinantan Wildlife and Cultural Park, Bukittinggi, West Sumatra. Jurnal Ilmiah Mahasiswa Pertanian, 6(4), 749-756. *http://dx.doi.org/10.17969/jimfp.v6i4.18183*.

ABSTRACT

Menurut IUCN (International Union for Conservation of Nature) harimau sumatera masuk kedalam kategori terancam punah (Critical endangered). Harimau sumatera termasuk salah satu hewan dengan tingkat perawatan yang sulit dan sangat rawan kematian. Kematian tersebut tak terkecuali di wilayah kawasan ex-situ. Penelitian ini menggunakan metode observsi dan Focal animal sampling yang dilakukan dari pukul 08.00 sampai dengan pukul 17.00 WIB. Persentase perilaku harian harimau sumatera secara umum di Taman Margasatwa dan Budaya Kinantan (TMSBK) yaitu Boncel melakukan perilaku bergerak (43%), istirahat (39%), individu (12%), sosial (3%) dan agonistik (3%). Perilaku yang dilakukan Bujang Kinantan yaitu perilaku bergerak (17%), istirahat (64%), individu (14%), sosial (1%) dan agonistik (3%). Perilaku Bancah selama pengamatan yaitu perilaku bergerak (12%), istirahat (62%), individu (17%), sosial (10%) dan agonistik (0%). Perilaku Dara Jingga yaitu perilaku bergerak (5%), istirahat (79%), individu (15%), sosial (1%) dan agonistik (0%). Berdasarkan persentase perilaku harian harimau yang diperoleh dapat dilihat bahwasanya perilaku istirahat lebih dominan tinggi pada tiap individu, tetapi pada harimau Boncel memiliki persentase perilaku bergerak yang dominan, dikarenakan umur Boncel terbilang masih muda.Journal Daily Behavior of Sumatran Tigers (Panthera tigris sumatrae) at Kinantan Cultural and Wildlife Park Bukittinggi West SumatraAbstract.

According to the IUCN (International Union for Conservation of Nature), the Sumatran tiger is in the critically endangered category. The Sumatran tiger is one of the animals with a difficult level of care and is very prone to death. These deaths are no exception in the ex-situ area. This research used observation method and Focal animal sampling which was conducted from 08.00 to 17.00 WIB. The percentage of daily behavior of Sumatran tigers in general at the Kinantan Wildlife and Culture Park (TMSBK) is that Boncel engages in moving behavior (43%), resting (39%), individual (12%), social (3%) and agonistic (3%). The behavior of Bujang Kinantan is moving behavior (17%), resting (64%), individual (14%), social (1%) and agonistic (3%). Bancah's behavior during the observation was moving behavior (12%), resting (62%), individual (17%), social (10%) and agonistic (0%). Dara Jingga's behavior is moving behavior (5%), resting (79%), individual (15%), social (1%) and agonistic (0%). Based on the percentage of daily behavior of tigers obtained, it can be seen that resting behavior is more dominant in each individual, but the Boncel tiger has a dominant percentage of moving behavior, because Boncel's age is relatively young.

Kiranaputri, G., Sjahfirdi, L., Tumbelaka, L. I., Yana, A., Priyanto, S. K., Anggarsari, L. Y., and Marizal, M. (2021). Positive Reinforcement Conditioning as Social Enrichment for Sumatran Tigers (Panthera tigris sumatrae) at Tambling Wildlife Nature Conservation Rescue Centre, Lampung, Indonesia. Biodiversitas Journal of Biological Diversity, 23(1), 55-61. *http://dx.doi.org/10.13057/biodiv/d230107*.

ABSTRACT

Tiger individuals are translocated to ex-situ conservations due to human-tiger conflicts and may express behavioral change (stereotypic) in captivity. Furthermore, medical check-up routines may cause injury and stress between tiger and operators under tough circumstances. Positive reinforcement conditioning (PRC) is a well-known method to minimize the risks on medical examination and as social enrichment. Therefore, the purposes of this research are (i) to examine PRC on tiger's blood sample collections and (ii) the correlation between physiological stress and tiger's stereotypic behavior (SB) through the neutrophil per lymphocyte ratio (N/L ratio) method. Four Sumatran tigers' (1 female, 3 males) behavior were observed using focal animal sampling at Tambling Wildlife Nature Conservation Rescue Centre, Lampung, Indonesia. Each baseline and post-enrichment tiger's behavioral observations were conducted for 1.920 minutes (1 male and 1 female) and 960 minutes (2 males). Then SB was categorized into low (<33,33%), intermediate (33,34-66,66%) or high (>66,67%). Blood collections (BC) were conducted twice (1st without PRC and 2nd with PRC) directly on the tiger after the behavior observation. Tiger's physiological stress during BC was analyzed with Wilcoxon. The correlation between physiological stress and SB was analyzed with Kruskal-Wallis. All tigers' N/L ratios were in normal value from this present research during both BC. The tigers did not show chronic stress as long as this research was conducted. PRC was significantly effective to reduce tiger physiological stress during BC (Z= -0,730, P= 0,465 < 0,05). All tigers showed low (<33,33%) pacing SB (without fur-plucking, self-biting, and self-mutilation behavior) both in baseline and post-enrichment. Any fur-plucking, self-biting and self-mutilation behaviors were not observed. Physiological stress was not correlated to SB (X2= 3, P= 0,392 > 0,05). The PRC was an appropriate and effective tool to handle Sumatran tigers during BC. These tigers performed SB as a coping mechanism in the enclosure.

Kurniawan, B., Ningsih, S., Susanti, T., and Farikhatin, F. (2021). Behavior Analysis of Sumatran Tiger (Panthera tigris sumatrae, Pocock, 1929) in Taman Rimba Zoo Jambi. IOP Conference Series: Materials Science and Engineering, 1098(5), 52076. *http://dx.doi.org/10.1088/1757-899x/1098/5/052076*.

ABSTRACT

The Sumatran tiger (Panthera tigris sumatrae) is an endemic animal on the island of Sumatra that is nearing extinction. Ex-situ conservation efforts such as at zoos have an important role in preserving and increasing populations through breeding and maintenance programs. Habitat changes can cause changes in daily behavior patterns because they have different habitat characteristics. The purpose of this study was to determine the habitat characteristics and daily behavior of Sumatran tigers in the Taman Rimba Zoo Jambi. This research was conducted for 12 hours / day starting at 7:00 to 19:00. There are two female Sumatran tigers used as objects in this study. The description of ex-situ habitat characteristics is done through direct observation and literature reference as a comparison. Daily behavior of Sumatran tigers includes eating behavior, resting behavior, social behavior, and others. Ex-situ habitat characteristics generally have similarities with their natural habitat to meet the basic needs of tigers. The results of recording daily behavior in the parent and cubs have a value with a percentage of feeding behavior (2.2% and 2.92%), resting behavior (87.92 and 85.97 %%), social behavior (3.43% and 4.05%), and others (6.43% and 7.06%).

HUMAN WILDLIFE INTERACTION AND CONFLICT MITIGATION

Patana, P., Alikodra, H. S., Mawengkang, H., and Harahap, R. H. (2021). Mitigation Strategy of Human-Tiger Conflict in Leuser Ecosystem Using SWOT Matrix. IOP Conference Series: Earth and Environmental Science, 782(3), 32034-. *http://dx.doi.org/10.1088/1755-1315/782/3/032034*.

ABSTRACT

Human and tiger conflict (HTC) has become one of the main drivers' factor of the decline population of the Sumatran tiger (Panthera tigris sumatrae). The Leuser Ecosystem is an important landscape for tiger habitat covering13 districts in Aceh Province and 4 districts in North Sumatra. The purpose of this study was to analyse the HTC mitigation strategy based on internal and external factors at Leuser. The location was chosen by purposive sampling in two potential areas of conflict, namely Timbang Lawan (TL) Village, in Langkat Regency and Panton Luas (PL) Village in South Aceh Regency. These two villages are directly adjacent to the tiger habitat. Data collection was carried out through field observations, interviews and focus group discussions. Respondents are experts and people living in conflict areas. The analysis was

carried out using SWOT to measure IFAS (strengths and weaknesses) and EFAS (opportunities and threats). The results of the SWOT analysis show the differences in the mitigation strategies of each location. The comparison of IFAS and EFAS values places Timbang Lawan in quadrant III (WO strategy) while Panton Luas in quadrant I (SO strategy).

Patana, P., Afifuddin, Y., and Sulistiyono, N. (2021). Causal Loop of System Thinking in Mitigating Human-Tiger Conflict Based Livelihood around Leuser. IOP Conference Series: Earth and Environmental Science, 782(3), 32037. *http://dx.doi.org/10.1088/1755-1315/782/3/032037*.

ABSTRACT

Human tiger conflict (HTC) has become serious problem in Indonesia in term of conservation effort of Sumatran tiger (Panthera tigris sumatrae) since population of this species has declined in recent years. The threat of tiger death increases following the number of conflict accidents with humans. The solution requires a comprehensive approach, because it involves the interests of parties. This research was conducted around Gunung Leuser National Park by purposive sampling in Bahorok (Langkat Regency) and Tapaktuan (South Aceh Regency). This study used the system thinking approach in looking at the variables that affected the complexity of HTC. Analysis of needs resulted variables as controlled input of model that describing by causal loop. This study will see the interrelationship of conflict-causing factors with the livelihoods of forest communities. Five aspects of livelihood that became the focus of research consisted environmental, economic, social, human and physical resources. The causal loop of each variable reflected in a diagram.

Rizal, A., Siregar, Y. I., and Nofrizal, S. P. (2021). Risk Level of Human and Sumateran Tigers (Panthera Tigris Sumatrae) In Pt. Arara Abadi Distrik Tapung Industrial Forest. Jurnal Ilmu Lingkungan, 15(2), 121-129. *http://dx.doi.org/10.31258/jil.15.2.p.121-129*.

ABSTRACT

IUCN (International Union for Conservation of Nature) categorizes the Sumatran tiger as an endangered species in crisis, which is the highest category of extinction threat. One of the causes of the extinction of the Sumatran tiger is conflict with humans. The meeting of human activities and the roaming area of tigers in the same space creates an adverse conflict on both sides.This research was conducted in the Hutan Tanaman Industri of PT. Arara Abadi, Tapung District, located in Siak Regency and Kampar Regency, Riau Province, to be precise in Rantau Bertuah Village and Garo City Village. The research method is a qualitative approach. Primary data obtained from observations and interviews, and document studies. Secondary data obtained from literature studies are landscape maps, animal monitoring data, and biodiversity

reports of PT. Arara Abadi, Tapung district. In addition, the literature study is also sourced from the Riau BKSDA wildlife monitoring data document. Result: Conflict between humans and Sumatran tigers occurred in the concession area of PT. Riau Abadi Lestari to be precise in a conservation area, in a community plantation area. The social losses that occur are in the form of psychological losses, while other losses such as human injuries or death do not occur. The economic loss was Rp. 42,000,000. In addition, some residents lost their working days to cultivate their gardens. The frequency of conflicts that occurred in Rantau Bertuah Village did not recur and conflicts that occurred in Kota Garo Village occurred repeatedly throughout 2020.Conflicts that occur in Rantau Bertuah Village are low risk. Meanwhile, the conflict that occurred in the village of Kota Garo was included in moderate risk.

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATIONS

Selni, M., Mangunjaya, F. M., Praharawati, G., Tjamin, Y. R., and Bahagia. (2021). Knowledge, Perception, and Attitudes of the Community Toward the Desire to Conserve Endangered Wildlife. Edukatif: Jurnal Ilmu Pendidikan, 3(4), 1808-1820.
http://dx.doi.org/10.31004/edukatif.v3i4.579

ABSTRACT

Indonesia is an archipelagic country that has biodiversity with various types of flora and fauna. One of them is the Sumatran tiger (Panthera tigris sumatrae) whose population is categorized as critically endangered. This study aims to determine the effect of the socialization of the MUI fatwa on the knowledge, perceptions, and attitudes of the community through lectures on conservation science delivered by Ustadz who had previously attended training in the Bukit Rimbang-Baling area. The research method used is a quantitative method with statistical test equipment to determine the effect between variables X and Y. The sampling method is using purposive sampling. Meanwhile, data collection in the field used research instruments in the form of questionnaires which were distributed to the public. The results of this study show that knowledge has a relationship with action intentions for environmental conservation. Likewise, attitudes and perceptions have a relationship with the intention to conserve the environment. This study can be concluded that knowledge, perceptions, and attitudes have a relationship with the intention to carry out environmental conservation activities.

MONITORING AND ASSESSMENT

Ariyanto, T., Dinata, Y., Dwiyanto, N., Sugito, W., Turyanto, E., Kirklin, S., and Amin, R. (2021). Status of the Sumatran Tiger in the Berbak-Sembilang Landscape (2020). Journal of Threatened Taxa, 13(6), 18419-18426. *http://dx.doi.org/10.11609/jott.6271.13.6.18419-18426*

ABSTRACT

Monitoring the status of the Critcally Endangered Sumatran Tiger Panthera tgris sumatrae is a key component for assessing the efectveness of conservaton interventons, and thus informing and adaptng strategic planning for the remaining 600 Sumatran Tigers on the island. The Berbak-Sembilang Natonal Park is an integral part of the priority Berbak-Sembilang Tiger Conservaton Landscape, in a unique habitat of mixed peat and freshwater swamp in eastern Sumatra. Our camera trap survey covered both the Berbak and Sembilang Tiger Core Areas (BTCA, STCA) over a period of 10 years, with surveys undertaken in 2010, 2015, 2018–2019. The most recent populaton density estmates (BTCA 1.33 adults/100 km^2, 95% CI 0.82–1.91 with 19 adults; and STCA 0.56 adults/100 km^2, 95% CI 0.45–0.89 with fve adults) confrmed a small but stable populaton. A landscape level management approach is a priority for tger populaton recovery, consolidatng ground-based protecton and establishing a well-maintained fre management system with reforestaton of afected areas along with mult-stakeholder engagement and partnerships. The study also recommends extending the BTCA to include the primary swamp forest in the north of the natonal park, based on evidence from camera trap surveys.

Patana, P., Saputri, M. W., and Marpatasino, N. (2021). The occurrence of Sumatran tiger (Panthera tigris sumatrae) in an industrial plantation forest area, North Sumatra, Indonesia. Indonesian Journal of Applied Environmental Studies, 2(1), 47-51.
http://dx.doi.org/10.33751/injast.v2i1.3079

ABSTRACT

Sumatran tiger lives in the remaining forests on the Sumatra island, both in conservation and production areas. There are not many tiger monitoring activities conducted in production forest. Using camera traps this occupancy survey of Sumatran tiger (Panthera tigris sumatrae) carried out in a plantation forest area of PT. Toba Pulp Lestari (PT. TPL) to obtain information and monitor tiger presence in the area. However, there were no Sumatran tigers captured by the camera traps during the occupancy activities. The existence of Sumatran tiger was proven by the finding of footprints and scrapes. Other species were photographed by the camera traps, such as marbled cat ((Pardofelis marmorata), pig-tailed monkey (Macaca nemestrina), treeshrew (Tupaia sp.), Asian palm civet (Paradoxurus hermaphroditus), lizards (Eutropis sp.), Hoogerwerf's pheasant (Lophura hoogerwerfi), wood mouse (Apodemus sylvaticus) as well as birds. It is assumed that the Sumatran tiger didn't cross the location of research during the camera installation period. However, there are several other reasons why Sumatran tigers weren't captured by camera traps, such as the camera traps observation time was too short and didn't cover a larger area, so it lessens the opportunity of encounter with Sumatran tiger.

Harimau Sumatera hidup di hutan yang masih tersisa di pulau Sumatera, baik di kawasan hutan konservasi maupun hutan produksi. Kegiatan pemantauan harimau di hutan produksi belum banyak dilakukan. Dengan menggunakan camera trap, survei okupansi harimau sumatera (Panthera tigris sumatrae) ini dilakukan di areal konsesi hutan tanaman industri PT. Toba Pulp Lestari (PT. TPL) untuk mendapatkan informasi dan memantau keberadaan harimau di kawasan tersebut. Namun, tidak ada harimau sumatera yang terfoto oleh kamera trap selama kegiatan survei okupansi. Keberadaan harimau sumatera dibuktikan dengan ditemukannya jejak tapak dan cakaran. Selain itu, terdapat ppesies lain yang terfoto oleh kamera trap, seperti kucing batu ((Pardofelis marmorata), beruk (Macaca nemestrina), tupai tanah (Tupaia sp.), musang pandan (Paradoxurus hermaphroditus), kadal (Eutropis sp.), sempidan aceh (Lophura hoogerwerfi), tikus hutan (Apodemus sylvaticus) serta burung. Diasumsikan bahwa harimau sumatera tidak melintasi lokasi penelitian selama masa pemasangan kamera. Namun, terdapat beberapa alasan lain mengapa harimau sumatera tidak terfoto kamera trap, seperti waktu pengamatan kamera trap yang terlalu singkat dan tidak mencakup area yang lebih luas, sehingga memperkecil peluang perjumpaan dengan harimau sumatera.

Rambe, I. F., Rambey, R., and Siregar, S. (2021). Species diversity, abundance, and wildlife conservation status in Batang Gadis National Park, North Sumatra, Indonesia. Biodiversitas Journal of Biological Diversity, 22(11), 5180-5196. *https://smujo.id/biodiv/article/view/9356*.

ABSTRACT

Species diversity, abundance, and wildlife conservation status in Batang Gadis National Park, North Sumatra, Indonesia. Biodiversitas 22: 5189-5196. Indonesia is one of the countries with the highest biodiversity in the world. Furthermore, the biodiversity of floral and faunal species is still being monitored and maintained, one of which is in the forest of the National Park. Batang Gadis National Park is a habitat for various species of endemic Sumatran wildlife, most of which are endangered species in the world. Therefore, this study aimed to inventory wild animals and to calculate their abundance in the Batang Gadis National Park. The study used camera traps as recording devices that were installed on permanent and non-permanent plots based on evidential animal trajectories in the National Park Management Section Region III Resort 7 Forest of Ampung Padang Forest in 2018. In the permanent plot, 10 species were documented within nine families, namely the Felidae, Tapiridae, Cervidae, Viverridae, Ursidae, Tragulidae, Suidae, Tupaiidae, and the Cercopithecidae. The highest species abundance was Macaca nemestrina (36.17%), and the second-highest was Muntiacus muntjak Zimmermann (14.89%), and then Tapirus indicus Desmarest (10,64%). Also, the Sumatran tiger (Panthera tigris sumatrae Pocock) was in the fourth position with a value of 10.63% of species abundance. Meanwhile, the lowest abundance index value was from clouded leopard (Neofelis diardi Cuvier) with 2.12%. The abundance of species from the non-permanent plots using camera

trap documented a total of 13 species with 12 families namely Felidae, Tapiridae, Cervidae, Hystricidae, Viverridae, Muridae, Phasianidae, Tragulidae, Suidae, Muscicapidae, Tupaiidae, and Cercopithecidae. The highest was documented from wild boar (Sus scrofa Linnaeus) at 42.48% and the second-highest species abundance was macaque (N. nemestrina) at 26.144%. The lowest species abundance index values were tapir (T. indicus) and Javan blue robin (Myiomela diana Lesson) with 0,33% and 0,33 %, respectively. The existence of documented wildlife species in our study affirmsed the importance of Batang Gadis National Park as a natural habitat for some key and protected species.

Sulistiyono, N., Maulana, M. I., Patana, P., and Purwoko, A. (2021). Application of Geographic Information System (GIS) for mapping of spatial distribution characteristics of the Sumatran Tigers (Panthera tigris sumatrae) prey in Besitang. IOP Conference Series: Materials Science and Engineering, 1122(1), 12034. *http://dx.doi.org/10.1088/1757-899x/1122/1/012034*

ABSTRACT

This research is an example of GIS applications used in the field of conservation and landscape ecology. Sumatran tiger habitat management begins with knowing Sumatran tiger prey distribution. Information on Sumatran tiger prey distribution will be very useful in identifying the suitability of habitat for Sumatran tiger. This study objective to determine the spatial distribution of Sumatran tiger prey in Besitang forest. The method used is to overlay the coordinates of the tiger prey findings with the trigger factors that influence the distribution of Sumatran tiger prey using GIS. The results showed animals prey of Sumatran tiger in the Besitang area occurs mostly in sloping areas with low topography and regions that are relatively far to the road and near to the river.

Wibisono, H. T. (2021). An island-wide status of Sumatran tiger (Panthera tigris sumatrae) and principal prey in Sumatra, Indonesia [Doctoral dissertation], University of Delaware, United States. *https://udspace.udel.edu/handle/19716/29356*

ABSTRACT

A multilateral effort to establish priorities for global tiger conservation identified 76 Tiger Conservation Landscapes throughout the 13 tiger range countries, 12 are in Sumatra, Indonesia. Despite this designation of conservation landscapes, the status of the Sumatran tiger population is still in question, as existing range-wide density estimates were derived using findings from disparate approaches. Meanwhile, habitat fragmentation and loss continue to threaten the integrity of these landscapes, while demand for tiger body parts, prey depletion, and human–tiger conflict have been documented as causing a rapid decline in tiger numbers.

In Chapter 1, we jointly analyzed 29 camera trap datasets from 16 sites collected between 1999 and 2017 in a single multi-session model to allow estimating parameters across sites and sessions and tested a variety of models with different covariates for movement parameter (σ), detection probability (g0), and the density (D). We found that Sumatran tiger densities were significantly higher in lowland habitat and under protected status, that adult male tigers moved significantly further than adult females, and that the Sumatran tiger ranged over larger areas in montane habitats. In Chapter 2, we analyzed an animal sign-based detection/non-detection dataset collected along transects in 389 grid cells,17 by 17 km each, between 2007 and 2009, in 60% of the remaining tiger landscapes in Sumatra, Indonesia. We explored the effect of environmental and anthropogenic factors on the occupancy of Sumatran tiger, their main prey, and poaching and logging, using a multi-species occupancy model. We found that the occupancy of Sumatran tiger, sambar deer, and barking deer were higher in grid cells with higher percent of forest cover. Tiger and wild pig preferred lower elevations while barking deer preferred higher elevations. We found positive correlations.

ZOOLOGY AND ANIMAL WELFARE

Putu Laksmi Candra Dewi, Luh Putu Eswaryanti Kusuma Yuni, and Ni Luh Watiniasih. (2021). Daily activities of Sumatran tigers (Panthera tigris sumatrae) and Bengal tigers (Panthera tigris tigris) at Bali Zoo, Gianyar. Jurnal Biologi Udayana, 25(2), 189-189. *http://dx.doi.org/10.24843/jbiounud.2021.v25.i02.p11*.

ABSTRACT

Bali Zoo merupakan lembaga konservasi eksitu bagi berbagai jenis satwa, termasuk harimau benggala dan harimau sumatra. Kedua jenis ini termasuk dalam daftar IUCN dengan status terancam punah untuk harimau benggala dan status kritis untuk harimau sumatra. Penelitian ini bertujuan untuk mengetahui aktivitas harian kedua jenis harimau tersebut di Bali Zoo. Pengambilan dan pengumpulan data aktivitas harian dilakukan dengan metode focal animal sampling, pencatatan menggunakan metode instantaneous recording dengan interval 30 detik selama 30 menit. Pengambilan data dilakukan pada pagi, siang, dan sore hari. Kedua jenis harimau mengalokasikan waktunya paling banyak untuk beristirahat. Harimau sumatra mengalokasikan waktunya untuk istirahat sebesar 64,69 ± 2,52%, moving 31,32 ± 2,46%, grooming 2,72 ± 0,40%, buang air 0,37 ± 0,08%, makan 0,33 ± 0,11%, minum 0,31 ± 0,07% dan aktivitas sosial 0,26 ± 0,08%. Untuk harimau benggala, harimau ini mengalokasikan waktunya untuk istirahat sebesar 68,23± 2,20%, moving 24,14 ± 1,99%, sosial 3,54 ± 0,34%, grooming 2,23 ± 0,29%, buang air 0,39 ± 0,08%, minum 0,39 ± 0,09%, dan makan 0,08 ± 0,18%. Aktivitas pacing tercatat sangat rendah pada kedua jenis harimau mengindikasikan kondisi harimau yang cukup nyaman berada pada kandangnya.

Bongot Huaso Mulia, S., Mariya, S., Bodgener, J., Iskandriati, D., Rambu Liwa, S., Sumampau, T., Manansang, J., Darusman, H. S., Osofsky, S. A., Techakriengkrai, N., and Gilbert, M. (2021). Exposure of Wild Sumatran Tiger (Panthera tigris sumatrae) to Canine Distemper Virus. Journal of Wildlife Diseases, 57(2), 464-466. *http://dx.doi.org/10.7589/jwd-d-20-00144*.

ABSTRACT

Canine distemper virus (CDV) is recognized as a conservation threat to Amur tigers (Panthera tigris altaica) in Russia, but the risk to other subspecies remains unknown. We detected CDV neutralizing antibodies in nine of 21 wild-caught Sumatran tigers (42.9%), including one sampled on the day of capture, confirming exposure in the wild.

Dr. Sanjay Shukla

LAOS

MONITORING AND ASSESSMENT

Rasphone, A., Kamler, J. F., Tobler, M. W., and Macdonald, D. W. (2021). Density trends of wild felids in northern Laos. Biodiversity and Conservation, 30(6), 1881-1897. *http://dx.doi.org/10.1007/s10531-021-02172-0*.

ABSTRACT

Determining the density trends of a guild of species can help illuminate their interactions, and the impacts that humans might have on them. We estimated the density trends from 2013 to 2017 of the clouded leopards Neofelis nebulosa, leopard cat Prionailurus bengalensis and marbled cat Pardofelis marmorata in Nam Et—Phou Louey National Park (NEPL), Laos, using camera trap data and spatial capture-recapture models. Mean (± SD) density estimates (individuals/100 km^2) for all years were 1.77 ± 0.30 for clouded leopard, 1.50 ± 0.30 for leopard cat, and 3.80 ± 0.70 for marbled cat. There was a declining trend in density across the study years for all three species, with a ≥ 90% probability of decline for clouded leopard and leopard cat and an 83% probability of decline for marbled cat. There was no evidence that mesopredator release occurred as a result of tiger (Panthera tigris) and leopard (P. pardus) extirpations. We believe that snaring, the factor that led to the extirpation of tiger and leopard in NEPL, is now contributing to the decline of smaller felids, to an extent that over-rides any potential effects of mesopredator release on their densities and interactions. We recommend that the NEPL managers implement a more systematic and intensified snare removal program, in concert with extensive community outreach and engagement of local people to prevent the setting of snares. These actions might be the only hope for saving the remaining members of the felid community in NEPL.

MALAYSIA

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Lazarus, B. A., Che-Amat, A., Shah, M. M. A. H., Hamdan, A., Hassim, H. A., Kamal, F. M., Azizan, T. R. P. T., Noor, M. H. M., Mustapha, N. M., and Ahmad, H. (2021). Impact of natural salt lick on the home range of Panthera tigris at the Royal Belum Rainforest, Malaysia. Scientific Reports, 11(1), 10596-10596. *http://dx.doi.org/10.1038/s41598-021-89980-0*

ABSTRACT

Natural salt lick (sira) is a strategic localisation for ecological wildlife assemblage to exhibit geophagy which may act as a population dynamic buffer of prey and predators. Undoubtedly, many agree that geophagy at natural licks is linked to nutritional ecology, health and assembly places facilitating social interaction of its users. Overall, natural salt licks not only save energy of obtaining nutrient leading to health maintenance but also forms the basis of population persistence. The Royal Belum Rainforest, Malaysia (Royal Belum) is a typical tropical rainforest in Malaysia rich in wildlife which are mainly concentrated around the natural salt lick. Since this is one of the most stable fauna ecology forest in Malaysia, it is timely to assess its impact on the Malayan tiger (Panthera tigris) home range dynamics. The three-potential home ranges of the Malayan tiger in this rainforest were selected based on animal trails or foot prints surrounding the salt lick viz (e.g. Sira Kuak and Sira Batu; Sira Rambai and Sira Buluh and Sira Papan) as well as previous sightings of a Malayan tiger in the area, whose movement is dependent on the density and distribution of prey. Camera traps were placed at potential animal trails surrounding the salt lick to capture any encountered wildlife species within the area of the camera placements. Results showed that all home ranges of Malayan tiger were of no significance for large bodied prey availability such as sambar deer (Rusa unicolor), and smaller prey such as muntjacs (Muntiacus muntjac) and wild boar (Sus scrofa). Interestingly, all home range harbour the Malayan tiger as the only sole predator. The non-significance of prey availability at each home range is attributed to the decline of the Malayan tiger in the rainforest since tigers are dependant on the movement of its preferred prey surrounding natural salt licks. Thus, the information from this study offers fundamental knowledge on the importance of prey-predator interaction at salt lick which will help in designing strategy in rewilding or rehabilitation programs of the Malayan tiger at the Royal Belum Rainforest.

Rathika Ramasamy

CONSERVATION, MANAGEMENT AND POLICY RECOMMENDATION

Threats

Ten, D. C. Y., Jani, R., Hashim, N. H., Saaban, S., Abu Hashim, A. K. B., and Abdullah, M. T. (2021). Panthera tigris jacksoni population crash and impending extinction due to environmental perturbation and human-wildlife conflict. Animals, 11(4), 6-6. *http://dx.doi.org/10.3390/ani11041032*.

ABSTRACT

The critically endangered Malayan tiger (Panthera tigris jacksoni), with an estimated population of less than 200 individuals left in isolated rainforest habitats in Malaysia, is in an intermediate population crash leading to extinction in the next decade. The population has decreased significantly by illegal poaching, environmental perturbation, roadkill, and being captured during human–wildlife conflicts. Forty-five or more individuals were extracted from the wild (four animals captured due to conflict, one death due to canine distemper, one roadkilled, and 39 poached) in the 12 years between 2008–2019. The Malayan tigers are the first wildlife species to test positive for COVID-19 and are subject to the Canine Distemper Virus. These anthropogenic disturbances (poaching and human–tiger conflict) and environmental perturbation (decreasing habitat coverage and quality) have long been identified as impending extinction factors. Roadkill and infectious diseases have emerged recently as new confounding factors threatening Malayan tiger extinction in the near future. Peninsular Malaysia has an existing Malayan tiger conservation management plan; however, to enhance the protection and conservation of Malayan tigers from potential extinction, the authority should reassess the existing legislation, regulation, and management plan and realign them to prevent further population decline, and to better enable preparedness and readiness for the ongoing pandemic and future threats.

NEPAL

HUMAN WILDLIFE INTERACTION AND CONFLICT MITIGATION

Sijapati, R. K., Sharma, H. P., Sharma, S., Subedi, J. R., and Belant, J. L. (2021). Livestock depredation by leopards and tigers near Bardia National Park, Nepal. Animals, 11(7), 1896. *http://dx.doi.org/10.3390/ani11071896*.

ABSTRACT

Wildlife attacks on livestock near human settlements are increasing due to the proximity of humans to protected areas. These attacks are often severe due to depredations of livestock adversely affecting the livelihoods of people. The nature of carnivore depredations on livestock can differ based on the carnivore species, animal husbandry practices, season, and deterrent technique. We surveyed people living near Bardia National Park (BNP), Nepal, to compare hoofed livestock depredations by leopards (Panthera pardus) and tigers (P. tigris) near (<1 km) and far (>1 km) from this protected area. Overall, 1476 hoofed livestock were reportedly depredated by leopards, and 209 by tigers, during 2015–2019. The number of hoofed livestock killed by leopards each season was, at least, 86% higher than the number killed by tigers. More livestock were killed at BNP irrespective of carnivore deterrent techniques used. Due to severe effects created by livestock depredations near BNP, we recommend using more efficacious deterrent techniques when practical, in addition to improved livestock husbandry practices such as night penning.

CONSERVATION, MANAGEMENT AND POLICY RECOMMENDATION

Bhattarai, B. R., Morgan, D., and Wright, W. (2021). Equitable sharing of benefits from tiger conservation: Beneficiaries' willingness to pay to offset the costs of tiger conservation. Journal of Environmental Management, 284, 112018. *https://doi.org/10.1016/j.jenvman.2021.112018*.

ABSTRACT

Costs of large predator conservation may not be equitably distributed among stakeholders; these include farming communities, tourism business owners and visitors. Financial redistribution mechanisms based on accrued benefits and costs of conservation require relevant data unavailable in many locations. To address this, a contingent valuation method identified willingness to pay (WTP) among national park visitors and connected tourism business owners. Both groups derive benefit from government-funded conservation policies.

The study was conducted in Bardia and Chitwan National Parks, Nepal 2017–2018; two locations world-renowned for tiger conservation. Local and international park visitors (N = 387) provided WTP for ongoing conservation via additional park entry fees. Tourism business owners (TBOs; N = 74) proximate to the parks stated their WTP for compensation funding provided directly to farmers. The majority (65%) of park visitors were willing to pay extra to support conservation (sample mean US$ 20) while 85 percent of TBOs supported their payment of funds for compensating farming communities (sample mean annual contribution being US$ 156). Valid WTP regression modelling found that visitor WTP was predicted by international travel costsand environmental organization affiliation. For TBOs indicating WTP, the amount to pay was predicted by annual net income from the tourism business. Application of study data indicates US$ 25 average increase to visitor park fees would maximise revenue and contribute a further US$ 495,000 available for conservation activities. Similarly, a flat-rate tariff on TBOs at the mean WTP amount would contribute more than double the annual budget available for farmer compensation (providing approximately US$ 43,000). More generally, the study findings are informative for policy-makers seeking equitable conservation outcomes while maintaining viable populations of critically endangered wild tigers. They should however be interpreted with caution given limitations of the sampling frame and method of data elicitation. Regardless, any policy decision effects require careful scrutiny to ensure desired outcomes are realized.

An, L., Bohnett, E., Battle, C., Dai, J., Lewison, R., Jankowski, P., Carter, N., Ghimire, D., Dhakal, M., Karki, J., and Zvoleff, A. (2021). Sex-specific habitat suitability modeling for Panthera tigris in Chitwan National Park, Nepal: Broader conservation implications. Sustainability, 13(24), 13885. *http://dx.doi.org/10.3390/su132413885*.

ABSTRACT

Although research on wildlife species across taxa has shown that males and females may differentially select habitat, sex-specific habitat suitability models for endangered species are uncommon. We developed sex-specific models for Bengal tigers (Panthera tigris) based on camera trapping data collected from 20 January to 22 March 2010 within Chitwan National Park, Nepal, and its buffer zone. We compared these to a sex-indiscriminate habitat suitability model to assess the benefits of a sex-specific approach to habitat suitability modeling. Our sex-specific models produced more informative and detailed habitat suitability maps and highlighted vital differences in the spatial distribution of suitable habitats for males and females, specific associations with different vegetation types, and habitat use near human settlements. Improving and refining habitat models for this and other critically endangered species provides the necessary information to meet established conservation goals and population recovery targets.

MONITORING AND ASSESSMENT

Bista, D., Lama, S. T., Shrestha, J., Rumba, Y. B., Weerman, J., Thapa, M. K., Acharya, H., Sherpa, A. P., Hudson, N. J., Baxter, G., and Murray, P. (2021). First record of Bengal Tiger, Panthera tigris tigris Linnaeus, 1758 (Felidae), in eastern Nepal. Check List, 17(5), 1249-1253. *http://dx.doi.org/10.15560/17.5.1249*.

ABSTRACT

We report the first record of a Bengal Tiger, Panthera tigris tigris, in eastern Nepal in 2020 based on photographic evidence. We documented this evidence at 3,165 m a.s.l., which makes it the highest elevation record of a tiger in Ne-pal. We recorded this evidence in one of 46 trail cameras deployed for monitoring Red Pandas in the Panchthar-Ilam-Taplejung (PIT) area. The PIT area, which has non-protected status, borders India in the east. Our finding supports the importance of transboundary conservation, which will benefit local and flagship wildlife in the PIT area.

ZOOLOGY AND ANIMAL WELFARE

McCauley, D., Stout, V., Gairhe, K. P., Sadaula, A., Dubovi, E. J., Subedi, S., and Kaufman, G. E. (2021). Serologic survey of selected pathogens in free-ranging Bengal tigers (Panthera tigris tigris) in Nepal. Journal of Wildlife Diseases, 57(2), 393-398. *http://dx.doi.org/10.7589/jwd-d-20-00046*.

ABSTRACT

Serum samples of 11 Bengal tigers (Panthera tigris tigris) from Chitwan National Park in Nepal, collected between 2011–17, were evaluated for the presence of antibodies to eight diseases commonly investigated in large felids. This initial serologic survey was done to establish baseline information to understand the exposure of Nepal's free-ranging tiger population to these diseases. Tiger serum samples collected opportunistically during encounters such as translocation, human conflict, and injury were placed in cold storage for later use. Frozen serum samples were assessed for feline coronavirus (FCoV), feline immunodeficiency virus, feline leukemia virus, feline herpesvirus (FHV), canine distemper virus, canine parvovirus-2 (CPV-2), leptospirosis (LEP; seven serovars), and toxoplasmosis (TOX). Six tigers were found to be positive for LEP, eight for CPV-2, five for FHV, one for FCoV, and 10 for TOX. Tigers, like other wild felids, have been exposed to these common pathogens, but further research is needed to determine the significance of these pathogens to the Nepali population.

RUSSIA

MONITORING AND ASSESSMENT

Lukarevskiy, V. S., Lukarevskiy, S. V., Kolchin, S. A., and Oleynikov, A. Y. (2021). Population structure and spatial distribution of the tiger (Panthera tigris, Felidae, Carnivora) in Southwestern Primorye (Russian Far East). Ecologica Montenegrina, 43, 1-15.
http://dx.doi.org/10.37828/em.2021.43.1

ABSTRACT

In 2011-2013, we surveyed the population structure, spatial distribution and the number of tigers in Southwestern Primorye (about 5000 km 2). The total number of tigers, according to winter route census, DNA analysis and camera trapping was estimated at 24-25 adults and 6-7 cubs, belonging to four different litters. The location of tigers is mainly confined to areas difficult to access for people, and with a high density of ungulates. Tigers concentrated in the habitat strip bordering China, mainly comprising the 'Land of the Leopard' National Park. A few tiger tracks were recorded outside of protected areas and on hunting tenures. Current methods for estimating tiger numbers needs critical reflection. Winter census by tracks in the

Internet

snow is often largely influenced by subjectivity. The main reason for this is the large number of surveyors of various degrees of qualification and as a result the conflicting interpretation of track identification. In our opinion, the most objective results are obtained from a consistent survey of the territory by a limited number of specialists and daily adjustments of collected materials. Precise and informative methods for determining the number and the structure of tiger populations are DNA analysis of biological samples combined with camera trap census. However, a number of significant drawbacks limits their widespread use: this method is labor-intensive and results in high project costs. In addition, weather conditions can greatly affect the preservation of DNA in the samples. There is a need to organize additional survey routes for installing camera traps and detecting of biological samples in order to register the tigresses with young, as they are behavior is often distinguished by a more secretive lifestyle. As a rule, female tigers with young avoid the main movement routes of adult tigers. These methods are expedient only in the smaller survey plots of model areas.

Rozhnov, V. V., Naidenko, S. V., Hernandez-Blanco, J. A., Chistopolova, M. D., Sorokin, P. A., Yachmennikova, A. A., Blidchenko, E. Y., Kalinin, A. Y., and Kastrikin, V. A. (2021). Restoration of the Amur Tiger (Panthera tigris altaica) Population in the Northwest of Its Distribution Area. Biology Bulletin, 48(8), 1401-1423. *http://dx.doi.org/10.1134/s1062359021080239*

ABSTRACT

The results of Amur tiger (Panthera tigris altaica) grouping recovery in the North-West of its distribution area are presented in this article. An analysis of tiger cubs specially trained for wildlife and released includes: establishing the spatial structure, the ability to find and hunt natural prey, the reaction to anthropogenic landscapes, facilities and infrastructure, and reproductive relationships. The young released tigers adapted to the wild successfully, developed a specifically actual spatial structure, hunted for wild prey, did not initiate carnivore-human conflicts, females brought offspring repeatedly, wild born younglings dispersed in this part of the range successfully. Thus, in the northwest of the distribution area of the Amur tiger, where in the 1970's this species was totally exterminated, its grouping has presently recovered and stabilized. The total grouping numbers currently amount to at least 20 individuals. The restoration of the Amur tiger grouping is based on the technology developed and used by the Severtsov Institute of Ecology and Evolution of the Russian Academy of Sciences for orphaned tiger cub rehabilitation and training for wildlife.

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATION

Skidmore, A. (2021). Using crime script analysis to elucidate the details of Amur tiger poaching in the Russian Far East. Crime Science, 10(1), 16. *https://doi.org/10.1186/s40163-021-00150-z*

ABSTRACT

Poaching is the most direct threat to the persistence of Amur tigers. However, little empirical evidence exists about the modus operandi of the offenders associated with this wildlife crime. Crime science can aid conservation efforts by identifying the patterns and opportunity structures that facilitate poaching. By employing semi-structured interviews and participants observation with those directly involved in the poaching and trafficking of Amur tigers in the Russian Far East (RFE), this article utilizes crime script analysis to break down this criminal event into a process of sequential acts. By using this framework, it is possible account for the decisions made and actions taken by offenders before, during and after a tiger poaching event, with the goal of identifying weak points in the chain of actions to develop targeted intervention strategies. Findings indicate poaching is facilitated by the ability to acquire a firearm, presence of roads that enable access to remote forest regions, availability of specific types of tools/equipment, including heat vision googles or a spotlight and a 4 × 4 car, and a culture that fosters corruption. This crime script analysis elucidates possible intervention points, which are discussed alongside each step in the poaching process.

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Antonenko, T.V., Pysarev, S. V., Matsyura, A. and Antonenko, E.V. (2021). Cluster analysis in ethological research. Ukrainian Journal of Ecology, 11(2), 23-26. *http://dx.doi.org/10.15421/2021_65*.

ABSTRACT

Big cats are often on display in zoos around the world. The study of their time budget is the basis of ethological research in captivity. The paper considers the features of the behavior of the subfamily Pantherinae, the daily activity of animals in the summer, methods of keeping, the exposition of enclosures, and relationships with keepers. The studies were conducted in the summer of 2012 and 2013 at the Barnaul Zoo. The total observation time for the animals was 120 hours. The behavior of the African lion (Panthera leo leo – male), the Ussuri tiger (Panthera tigris altaica – female), and the Amur leopard (Panthera pardus orientalis – male) has been studied. In the course of the work, the compilation of ethograms, continuous recording, and free observations were used. The clustering method was applied to analyze the patterns of behavior of animals in captivity. Cluster analysis breaks down the behavior of captivities animals into two large blocks. Locomotion in animals should be considered as a separate block. The animal's growth and development period require a high proportion of physical activity, which is noticeable when observing the Amur tiger. Locomotion occupied 32.8% of the total time budget of this animal. Large cats have never been in a shelter (in wooden structures of the appropriate size). They used the roof of the houses only as a place for rest and observation. The proportion of marking, hunting, eating, exploratory behavior, grooming, and such forms of behavior as freezing, static position, orienting reaction did not differ significantly. Play behavior with elements of hunting and manipulative activity took 5.5% of the Amur tiger's time budget for the period under review. We associate this primarily with the age of the given animal. Play behavior was observed two times less often in the Far Eastern leopard (2.9%) and African lion (2.6%).

Rozhnov, V. V., Naidenko, S. V., Hernandez-Blanco, J. A., Chistopolova, M. D., Sorokin, P. A., Yachmennikova, A. A., Blidchenko, E. Y., Kalinin, A. Y., and Kastrikin, V. A. (2021). Restoration of the Amur Tiger (Panthera tigris altaica) Population in the Northwest of Its Distribution Area. Biology Bulletin, 48(8), 1401-1423. *http://dx.doi.org/10.1134/s1062359021080239*

ABSTRACT

In populations of wild felids, social status is one of the most important factors shaping home range size and spacing patterns. For female Amur tigers (Panthera tigris altaica), we documented significant changes to the structure of home ranges and core areas during cub-rearing. We used VHF telemetry data collected over 18 years in Sikhote-Alin Biosphere Reserve, Russia, to assess the following: (1) home range and core area size and (2) spatial shifts with and without cubs and (3) spatial shifts associated with philopatry. Home range and core area sizes of females collapsed by 60% after birthing, with recovery requiring 18 months. We hypothesized that usurpation of temporarily abandoned territory by other females during cub-rearing was a possibility, but aside from philopatry, we did not observe a loss of territory or evidence of competition for space. Home range boundaries changed little during cub-rearing but shifting core areas revealed that females were using different segments of their home range while rearing cubs, contradicting the notion of a single, most important core area for breeding females. Our results support two hypotheses of space use by large carnivores: that adult breeding females achieve higher reproductive success by maintaining a home range just big enough to feed herself and her offspring, and a second hypothesis that females expand home range size when space is available to allocate land to daughters. We suggest that these hypotheses are not mutually exclusive, but explain patterns of space use by female felids under different demographic conditions.

Morphology

Zhilin, R. A., Korotkova, I. P., Lyubchenko, E. N., Kozhushko, A. A., and Kapralov, D. V. (2021). Distinctive features of the morphometric parameters of the heart of the Amur tiger (Panthera tigris altaica) in natural habitat and in captivity. E3S Web of Conferences, 258, 4010. *http://dx.doi.org/10.1051/e3sconf/202125804010*.

ABSTRACT

In the process of working with anatomical material supplied to the Animal Disease Diagnostic Center of the Primorskaya State Agricultural Academy, in the order of forensic examinations, a characteristic feature consisting in differences in the structure of the organs of animals living in natural habitat and in captivity was revealed. Evolutionary forces are reflected in the adaptability of animals to survive in the wild, honing adaptive characteristics and sweeping away all unnecessary things. Studying previously published works on the topic in question, it can be noted that the heart of animals in their natural habitat is slender, with a strong left side and relatively weak right side. As a rule, trabecular structures in such animals are smoothed, maximally "built" into the walls of the heart chambers. It is not often possible to find crossbeams as an element of myoendocardial formations in wild animals. However, for the internal structures of the human heart and domesticated animal species, this is not uncommon. There is an opinion that additional muscle-trabecular elements, such as: muscle crossbeams [3]; additional papillary muscles; pectinate muscles of the atria, located in a storey network - take part in the intensification of heart contractions and the creation of a swirling blood flow, providing its translational-rotational movement. This process can be considered an adaptive response to a decrease in physical activity during the evolution of a species, formed from birth to death of an organism. In the course of postmortem examinations, we examined the heart of a four-year-old female Amur tiger raised in captivity with the distinctive features of myoendocardial formations in comparison with other individuals of this species.

GENETICS

Derunov, D., Chasovskih, O., Sukhih, O., Buldakova, K., and Kokorina, A. (2021). Comparative analysis of wild and domestic animals' hair species. IOP Conference Series: Earth and Environmental Science, 677(4), 42007. *http://dx.doi.org/10.1088/1755-1315/677/4/042007*.

ABSTRACT

The article reveals the search for a fast and reliable techniques for identifying hair samples from wild animals, which occur during an expert evaluation in the Amur branch of WWF Russia. The

relevance of the presented data is that the main methods for determining the species of hair are electron microscopy, analysis by spectrogram or chemical composition of the hair, which is a long-term method and requires special equipment. In practice, the above-root parts of hair are often received for examination, and it is unsuitable for genetic research since some have already passed through the digestive tract. The authors considered the search for a technique that allows analyzing the hair of the Amur tiger (Panthera tigris altaica), Domestic cat (Felis catus domesticus) and Domestic dog (Canis lupus familiaris) in comparison, the method of imprints on gelatin, on a photographic plate, and on a colorless varnish was applied. As a result of the research, one method was chosen for analyzing hair samples on a colorless varnish with subsequent microscopy. Measurements of hair samples were compared in Microsoft Excel, with the construction of charts, using the "trend line" and "linear forecast" functions to predict the average measurement result and "error limits" with the "standard error" function to determine the permissible deviations of measurement results. As a result, we found that samples from different parts of the body of wild and domestic animals are well analyzed in the Microsoft Excel program with the expression of a linear trend, which allows us to determine the permissible deviations of the measurement results.

ZOOLOGY AND ANIMAL WELFARE

Poddubnaya, N. Y., Salkina, G. P., Eltsova, L. S., Ivanova, E. S., Oleynikov, A. Y., Pavlov, D. D., Kryukov, V. K., and Rumyantseva, O. Y. (2021). Mercury content in the Siberian tiger (Panthera tigris altaica Temminck, 1844) from the coastal and inland areas of Russia. Scientific Reports, 11(1), 6923. *http://dx.doi.org/10.1038/s41598-021-86411-y*.

ABSTRACT

Being a global pollutant, mercury can originate from both natural as well as anthropogenic sources. Coastal marine atmospheric fog is considered a potential source of ocean-derived monomethylmercury (MMHg) to coastal terrestrial ecosystems. However, the ratio between mercury appearing through natural processes and that from the results of human activity is unclear. We assumed that the total mercury content in the fur of tigers would differ depending on the distance from the sea. Here we show that the average mercury content in tigers from the coast (0.435 ± 0.062 mg kg^{-1}) is significantly different from tigers from the inland area (0.239 ± 0.075 mg kg^{-1}), ($p = 0.02$). We found that the content of mercury in the fur of tigers is largely dependent of natural processes rather than human activity. We assume that the levels of mercury in coastal ecosystems in the south of the Russian Far East reflect the position of the region relative to the deep faults of the East Pacific Platform. Obtained data indicate that environmental risks associated with mercury pollution currently exist, but do not pose a serious threat to Siberian tigers.

Ritzler, C. P., Lukas, K. E., Bernstein-Kurtycz, L. M., and Koester, D. C. (2021). The effects of choice-based design and management on the behavior and space use of zoo-housed Amur tigers (Panthera tigris altaica). Journal of Applied Animal Welfare Science: JAAWS, 26(2), 1-14. *http://dx.doi.org/10.1080/10888705.2021.1958684*.

ABSTRACT

Choice-based design allows animals in human care opportunities to move at will between multiple interconnected spaces. Some evidence suggests providing environmental choice confers benefits to animals, but there is a dearth of research in this area with large carnivores. To understand the effects of this design strategy on large felids, behavioral and space use data were collected on three Amur tigers housed in a new habitat at Cleveland Metroparks Zoo. Data were collected in two conditions: 1) restricted to a single habitat, and 2) access to two habitats. With choice, tigers were less frequently inactive (p = 0.003), and locomoted more frequently (p = 0.009). They also showed different preferences in space use with choice, and a strong preference for overhead runways between habitats (E* = 0.83, E* = 0.78). These results add to what is known about environmental impacts on zoo animal behavior and suggest this design and management strategy may be effective in conferring positive welfare benefits to tigers and other large carnivores.

Sandesh Kadur

THAILAND

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Ash, E., Kaszta, Ż., Noochdumrong, A., Redford, T. and Macdonald, D.W. (2021). Environmental factors, human presence and prey interact to explain patterns of tiger presence in Eastern Thailand. Anim Conserv, 24: 268-279. *https://doi.org/10.1111/acv.12631*.

ABSTRACT

Thailand is one of the last strongholds for tigers Panthera tigris in mainland Southeast Asia. Evidence suggests heterogeneity in tiger presence in a globally important landscape in Eastern Thailand is potentially influenced by a complex interaction of prey, human presence and environmental conditions. Understanding these dynamics is of considerable importance for the conservation of tigers both in this landscape and elsewhere in their range. In this study, we examine which factors, among prey, human presence and environmental characteristics, best explain tiger presence in the Dong Phayayen–Khao Yai Forest Complex (DPKY). We collated survey data from 56,214 camera trap nights and evaluated the relationship between tiger presence and a suite of five prey, 11 human presence and eight environmental variables. We then used variance partitioning to discern the degree of variance in tiger presence explained by these factors. We documented strong, positive associations with wild boar Sus scrofa presence and prey richness, and strong, negative associations with human settlement density, public roads and presence of poachers. Environmental characteristics explained a greater relative proportion of variance (19.6%) in tiger presence than prey covariates alone (3.1%), particularly confounded with human presence (31.1%). This suggests that environmental variables, especially when accompanied by anthropogenic factors, could be used to model potential tiger occurrence where other data may be lacking. Our approach may be helpful in providing guidance for prioritizing habitat, evaluating the effect of human presence and identifying key prey to provide a foundation for tiger protection and recovery.

Charaspet, K., Sukmasuang, R., Khoewsree, N., Pla-Ard, M., Paansri, P., Keawdee, B., Chanachai, Y., and Bhumpakphan, N. (2021). Spatial and temporal overlaps of top predators: Dhole, tiger and leopard, and their potential preys in Huai Kha Khaeng Wildlife Sanctuary, Thailand. Biodiversitas Journal of Biological Diversity, 22(2), 580-592. *http://dx.doi.org/10.13057/biodiv/d220209*.

ABSTRACT

The study of the spatial-temporal overlap of top predators and their prey is important to understand competition among predators and predator-prey relationships so that the viable

populations of predators and other animals can be sustained. This research aimed to study the abundance of three top predators: Dhole (Cuon alpinus), tiger (Panthera tigris) and leopard (Panthera pardus), and their potential wild prey in Huai Kha Khaeng Wildlife Sanctuary, Thailand, and to investigate the spatial-temporal overlap between those three predators, and their potential wild prey. We tested two significant hypotheses: (i) tiger and leopard had the highest spatial-temporal overlap and the spatial overlap of dhole and leopard was higher in comparison to dhole and tiger due to a higher prey overlap; (ii) the three species of large carnivore avoided spatial-temporal overlap even if they were in the same area. The study was conducted using camera traps. In addition, the spatial-temporal overlap of large carnivores and their potential prey was studied to understand the important species of prey of these large carnivores. The results showed that the spatial overlap of tiger and leopard was the highest. Dhole had significant spatial overlap with leopard, which was higher in comparison to dhole and tiger. A significant temporal overlap of dhole and leopard was not found. Also, a significant temporal overlap of tiger and leopard was not found. The results were based on hypotheses that conformed to the niche overlap index of the potential prey and the temporal overlap coefficient. There were ten important species of potential prey of large carnivores: Sambar deer (Rusa unicolor), red muntjac (Muntiacus muntjak), gaur (Bos gaurus), banteng (Bos javanicus), wild boar (Sus scrofa), Malayan porcupine (Hystrix brachyura), large Indian civet (Viverra zibetha), Asiatic black bear (Ursus thibetanus), pig-tailed macaque (Macaca nemestrina) and red jungle fowl (Gallus gallus). The important recommendation is the protection of the sanctuary from wildfires which spread from the outside in, especially in dry evergreen forest. Food resources of herbivores in the area must be managed, as well as the prevention of epidemics from livestock to wild animals.

Suttidate, N., Steinmetz, R., Lynam, A. J., Sukmasuang, R., Ngoprasert, D., Chutipong, W., ... Radeloff, V. C. (2020). Habitat connectivity for endangered Indochinese tigers in Thailand. Global Ecology and Conservation, 29, e01718. *https://doi.org/10.1016/j.gecco.2021.e01718*.

ABSTRACT

Habitat connectivity is crucial for the conservation of species restricted to fragmented populations within human-dominated landscapes. However, identifying habitat connectivity for apex predators is challenging because trophic interactions between primary productivity and prey species influence both the distribution of habitats, and predator movement. Our goal was to assess habitat connectivity for Indochinese tigers (Panthera tigris) in Thailand. We quantified suitable habitat and dispersal corridors based an ensemble species distribution model that included prey distributions, primary productivity, and abiotic variables and was based on camera-trap data from 1996 to 2013 in 15 protected areas. We employed graph theory to evaluate the relative importance of habitat patches and dispersal corridors to the

overall connectivity network. We found that tiger occurrence models with and without prey distributions performed well (Area Under the Curve: 0.932–0.954). However, inclusion of prey distributions significantly improved model performance (P < 0.001). Protected areas with tigers at the time of our surveys were highly isolated with high resistance to movement within the dispersal corridors, and four of them have lost their tiger populations since. Potential habitat patches outside of protected areas were also mostly isolated, but it was encouraging to find that there is ample potential habitat that tigers are not occupying. The Huai Kha Kaeng - ThungYai habitat patch and Kaeng Krachan dispersal corridor were the most important for overall habitat connectivity. Generally, integrating prey distributions into assessments of connectivity is a promising approach that can be widely applied to predict species occurrence and delineate dispersal corridors, thereby supporting conservation planning of tigers and other large carnivores.

Movement Ecology

Simcharoen, A., Simcharoen, S., Duangchantrasiri, S., Vijittrakoolchai, C., and Smith, J. L. D. (2021). Exploratory dispersal movements by young tigers in Thailand's Western Forest Complex: The challenges of securing a territory. Mammal Research, 67(1), 21-30. *http://dx.doi.org/10.1007/s13364-021-00602-6*.

ABSTRACT

Habitat for tigers and many carnivores is fragmented and degraded to an extent that the existing land base supporting discrete tiger populations is often inadequate to maintain viable populations. Using fine-scale location data of dispersing tigers, we studied their exploratory movements in Thailand's Western Forest Complex (WEFCOM), where the last remaining viable tiger population in mainland Southeast Asia resides. We mapped 21,897 locations of three satellite-collared tigers as they made 11 forays from the vicinity of their natal areas in Huai Kha Khaeng Wildlife Sanctuary to four adjacent protected areas in WEFCOM and Myanmar. Our objectives were to describe (1) the spatial and temporal movements of dispersing tigers and (2) the quality of habitat moved through during dispersal and at the time they established a territory. We used the probability of tiger occupancy at hourly locations as a measure of quality of the habitat traversed by dispersing tigers, and we compared these probabilities of use to probabilities at hourly locations of resident, breeding females. Dispersal forays lasted 3 to 52 days and ranged from 29 to 301 km. During these forays, tigers explored areas where the probability of tiger habitat use ranged from 0.212 to 0.961. One dispersing female settled in a territory with a 0.721 probability of use in the range of use in the territories of 10 breeding females (p = 0.600–0.914). This study produced the first high temporal resolution data of tiger dispersal movements in a landscape where the occurrence and probability of use by tigers is

known. These data also support modeling of dispersal and landscape resistance that provides critical information for managers seeking to increase connectivity and extent of tiger habitat.

MONITORING AND ASSESSMENT

Ash, E., Macdonald, D. W., Cushman, S. A., Noochdumrong, A., Redford, T., and Kaszta, Ż. (2021). Correction to: Optimization of spatial scale, but not functional shape, affects the performance of habitat suitability models: A case study of tigers (Panthera tigris) in Thailand. Landscape Ecology, 36(6), 1837-1837. *http://dx.doi.org/10.1007/s10980-021-01218-6*

ABSTRACT

The article Optimization of spatial scale, but not functional shape, affects the performance of habitat suitability models: a case study of tigers (Panthera tigris) in Thailand, written by Eric Ash, David W. Macdonald, Samuel A. Cushman, Adisorn Noochdumrong, Tim Redford and Zaneta Kaszta, was originally published online on 12 January 2021 with Open Access under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

Ash, E., Kaszta, Ż., Noochdumrong, A., Redford, T., Chanteap, P., Hallam, C., ... Macdonald, D. (2021). Opportunity for Thailand's forgotten tigers: Assessment of the Indochinese tiger Panthera tigris corbetti and its prey with camera-trap surveys. Oryx, 55(2), 204-211. doi:10.1017/S0030605319000589.

ABSTRACT

Dramatic population declines threaten the Endangered Indochinese tiger Panthera tigris corbetti with extinction. Thailand now plays a critical role in its conservation, as there are few known breeding populations in other range countries. Thailand's Dong Phayayen-Khao Yai Forest Complex is recognized as an important tiger recovery site, but it remains poorly studied. Here, we present results from the first camera-trap study focused on tigers and implemented across all protected areas in this landscape. Our goal was to assess tiger and prey populations across the five protected areas of this forest complex, reviewing discernible patterns in rates

of detection. We conducted camera-trap surveys opportunistically during 2008–2017. We recorded 1,726 detections of tigers in 79,909 camera-trap nights. Among these were at least 16 adults and six cubs/juveniles from four breeding females. Detection rates of both tigers and potential prey species varied considerably between protected areas over the study period. Our findings suggest heterogeneity in tiger distribution across this relatively continuous landscape, potentially influenced by distribution of key prey species. This study indicates that the Dong Phayayen-Khao Yai Forest Complex is one of the few remaining breeding locations of the Indochinese tiger. Despite limitations posed by our study design, our findings have catalysed increased research and conservation interest in this globally important population at a critical time for tiger conservation in South-east Asia.

Phumanee, W., Steinmetz, R., Phoonjampa, R., Weingdow, S., Phokamanee, S., Bhumpakphan, N., and Savini, T. (2021). Tiger density, movements, and immigration outside of a tiger source site in Thailand. Conservation Science and Practice, 3(12), e560. *https://doi.org/10.1111/csp2.560*.

ABSTRACT

Landscape-scale strategies for conserving wild tigers emphasize the role of core breeding populations (source sites) to replenish surrounding areas which have lost tigers. In Southeast Asia, a few potential source sites remain, particularly Huai Kha Khaeng Wildlife Sanctuary, Thailand (HKK). We investigated tiger density in two reserves (Mae Wong, Khlong Lan: MWKL) adjacent to HKK where tigers and their prey were scarce due to historic poaching but current management offered effective protection. Camera trapping revealed 10 adult tigers (four males, six females), at least two of which had immigrated from HKK. Spatially explicit tiger density was 0.359 tigers/100 km^2, 5.6 times lower than HKK. The population was breeding, with six cubs observed. Tiger movements (measured by σ, the spatial scale parameter) were twice as extensive in MWKL as in HKK, indicative of prey scarcity in MWKL. The disparity in density between MWKL and HKK reveals that tiger recovery is a slow process when prey are scarce, even when recovery areas are apparently well-managed and connected to a source site. We review source-recovery dynamics of tigers in other sites in Asia and find that low prey impedes landscape-scale recoveries elsewhere as well. Landscape-scale recovery of wild tigers is impeded by prey depletion, even when recovery areas are connected to a source population.

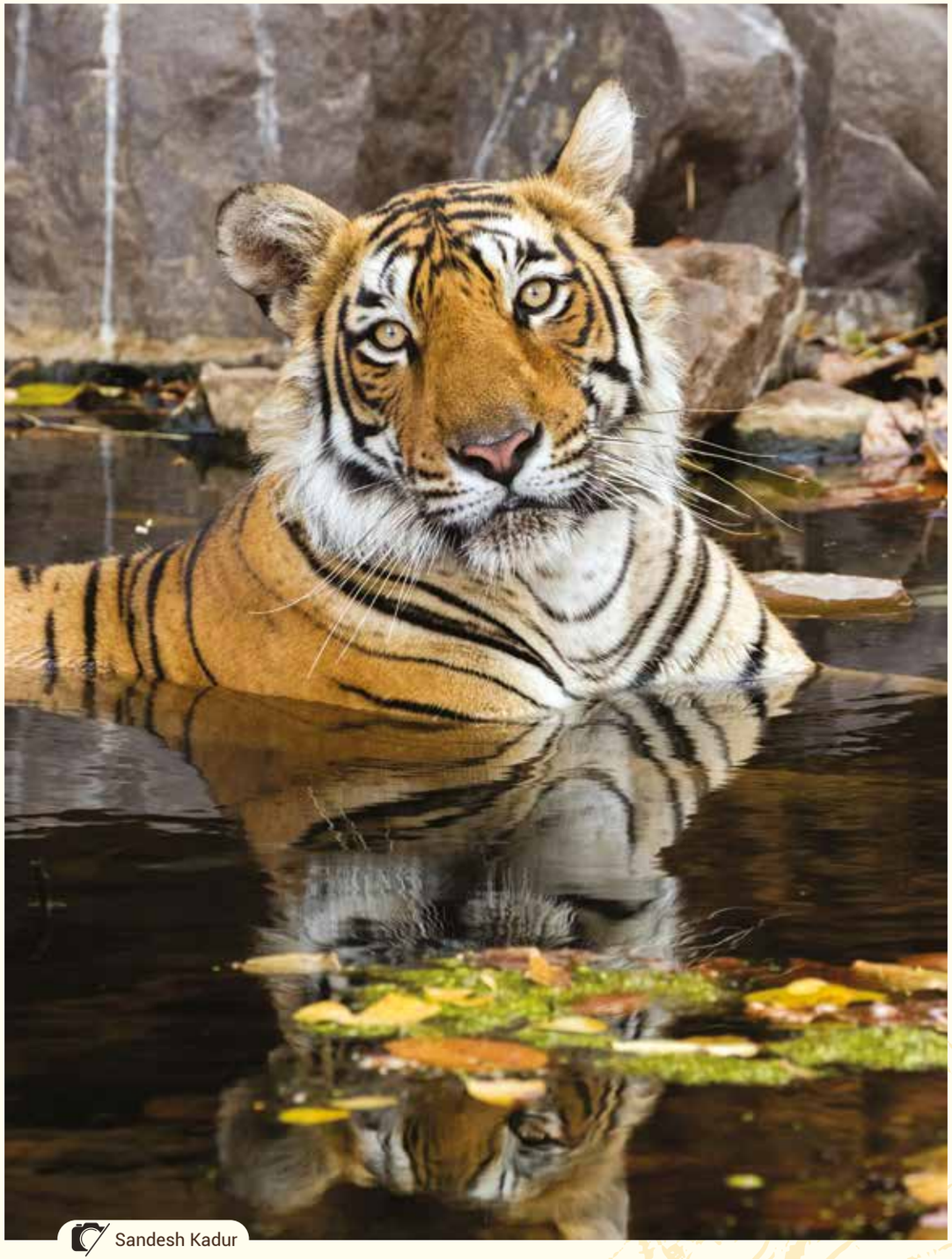
TRANSBOUNDARY

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Greenspan, E., Montgomery, C., Stokes, D., Wantai, S., and Bwe Moo, S. S. (2021). Large felid habitat connectivity in the transboundary Dawna-Tanintharyi landscape of Myanmar and Thailand. Landscape Ecology, 36(11), 3187-3205.
http://dx.doi.org/10.1007/s10980-021-01316-5.

ABSTRACT

Context: Maintaining landscape connectivity for large felids by preserving and restoring corridors between core habitats is crucial to their long-term conservation. Tiger, leopard, and clouded leopard populations occur in isolated habitat patches across the Dawna-Tanintharyi Landscape (DTL) of Kawthoolei (all Karen National Union administrative areas in Myanmar) and Thailand. Objectives: We analyzed connectivity among 18 habitat patches in this transboundary region based on large felid presence and expert opinion of large felid dispersal requirements. Methods: Least-cost corridor and circuit theory analyses were used to identify corridors, determine corridor quality and their relative importance to connectivity in the landscape, and pinpoint bottlenecks to movement. Results: Forty-eight corridors were identified. Lower resistances to dispersal were in forested montane areas. High-quality corridors remained in the northern DTL and south of Tanintharyi Nature Reserve in Kawthoolei based on cost-weighted distance to least-cost path ratio. Pairwise current pinch point analyses revealed a possible landscape level bottleneck to movement north of Thailand's Western Forest Complex. Area corrected centrality scores indicated smaller habitat patches disproportionately contributed to landscape connectivity. Conclusions: The DTL may retain connectivity across the landscape if conservation actions are taken to protect integral habitats and corridors. Conservation efforts that expand the protected area network in Kawthoolei, either by increasing the size of current protected area habitats or by demarcating new protected areas in regions with confirmed felid presence, will aid DTL connectivity. The DTL should be managed to preserve connectivity on both sides of the border, entailing international governmental, indigenous community, and non-governmental collaboration.



Sandesh Kadur

Nirmalya Chakraborty

ASIA

2022

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Hayward, M. W., Bugir, C., Lyngdoh, S., and Habib, B. (2022). Prey Preferences of the Large Predators of Asia. In O. Ilyas and A. Khan (Eds.), Case Studies of Wildlife Ecology and Conservation in India (pp. 11-17).

ABSTRACT

The endangered snow leopard is a large felid that is distributed over 1.83 million km^2 globally. Throughout its range it relies on a limited number of prey species in some of the most inhospitable landscapes on the planet where high rates of human persecution exist for both predator and prey. We reviewed 14 published and 11 unpublished studies pertaining to snow leopard diet throughout its range. We calculated prey consumption in terms of frequency of occurrence and biomass consumed based on 1696 analysed scats from throughout the snow leopard's range. Prey biomass consumed was calculated based on the Ackerman's linear correction factor. We identified four distinct physiographic and snow leopard prey type zones, using cluster analysis that had unique prey assemblages and had key prey characteristics which supported snow leopard occurrence there. Levin's index showed the snow leopard had a specialized dietary niche breadth. The main prey of the snow leopard were Siberian ibex (Capra sibrica), blue sheep (Pseudois nayaur), Himalayan tahr (Hemitragusjemlahicus), argali (Ovis ammon) and marmots (Marmota spp). The significantly preferred prey species of snow leopard weighed 5565 kg, while the preferred prey weight range of snow leopard was 36–76 kg with a significant preference for Siberian ibex and blue sheep. Our meta-analysis identified critical dietary resources for snow leopards throughout their distribution and illustrates the importance of understanding regional variation in species ecology; particularly prey species that have global implications for conservation.

BHUTAN

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Dorji, K., Sheeran, L. K., Barlow, K., Dorji, N. P., Dorji, T., and Dorji, W. (2022). Oleps' Traditional Beliefs of the Clouded Leopard, the Top Predator of Bhutan. Asian Social Science, 18(12), 8. *https://doi.org/10.5539/ass.v18n12p8*

ABSTRACT

The Oleps are the first human inhabitants of Bhutan and the country's last remaining hunter-gatherers. We conducted a preliminary study into the meaning of the traditional Bhutanese saying tog-ge-teng-nang-gong; gong-ge-teng-nang-thee (Ole) and tag-ge-ta-lay-gung; gung ge-ta-lay-theb (Dzongkha). Tag in Dzongkha refers to Bengal tiger (Panthera tigris) and gung refers to clouded leopard (Neofelis nebulosa). The saying describes the existence of a species, which Oleps people believe is the clouded leopard, that is superior to the apex predator the tiger. The saying is further elaborated as gung-gi-ta-lay-theb (Dzongkha), which means that a skilled human hunter is superior to the clouded leopard. We used semi-structured interviews to ask 19 Oleps people to explain this traditional saying and narrate the beliefs embedded in it. Participants related the saying to their views of the clouded leopard, and we explored how these views might influence the current conservation status of clouded leopards living in the Oleps' locality. Our interviews showed that Oleps revered and respected clouded leopards, but they also viewed them and other wild cats as harmful to livestock, and some expressed a desire to acquire clouded leopard pelts or to keep them as pets. Indigenous knowledge and beliefs are important to consider in the development of a conservation plan for clouded leopards. We recommend that Oleps' sayings and stories be documented for posterity and that conservationists continue to engage in dialog with Oleps people to better understand the effects clouded leopards and other wild cats have on their livelihoods.

CAMBODIA

BIOLOGY, ECOLOGY AND NATURAL HISTORY

van Berkel, T., Emsens, W.-J., Un Eam, S., Simoes, S., Puls, S., Rin, N., Kimsan, L., and Jocqué, M. (2022). Population density, habitat use and activity patterns of endangered hog deer in Cambodia. Mammal Research, 67(3), 311-316. *https://doi.org/10.1007/s13364-022-00619-5*

ABSTRACT

Hog deer (Axis porcinus) were once widespread throughout much of lowland Southern Asia, but numbers rapidly declined during the last two decades. In Cambodia, the species was considered extinct until 2006 when a small number of individuals (presumedly spp. annamiticus) was rediscovered along the western bank of the Mekong River, near Kratie. Since reliable data on this population are lacking, we conducted two camera trap surveys to investigate hog deer habitat use, activity patterns and density. In the first survey, camera traps were placed in a random regular grid covering all main habitat types in the region, enabling us to verify hog deer presence/absence and identify habitat use. We found that hog deer were confined to a remnant patch of tall moist grassland of approximately 2 km^2, at least in the dry season. The follow-up survey was conducted exclusively in this tall grassland patch, in which we estimated hog deer activity patterns and density using kernel density estimation and a simplified version of the random encounter model (REM). Cameras were active for a total of 1770 camera trap days, during which 609 independent hog deer encounters were recorded. Density was estimated to be 41.8 (CI: 37.93–45.72) individuals km−2, equating to an estimated abundance of 84 individuals. Hog deer activity was mainly crepuscular and nocturnal. We conclude that the recently rediscovered hog deer population in Kratie province is extremely vulnerable to extinction due to its small size and its complete dependency on a tiny remnant patch of core habitat. Conservation and restoration actions to preserve and restore prime habitat are urgently required to prevent local extinction.

TRADITIONAL MEDICINE

Lim, T., Davis, E. O., Crudge, B., Roth, V., and Glikman, J. A. (2022). Traditional Khmer Medicine and its role in wildlife use in modern-day Cambodia. Journal of Ethnobiology and Ethnomedicine, 18(1), 61. *https://doi.org/10.1186/s13002-022-00553-5*.

ABSTRACT

Individuals across Cambodia depend on the use of natural products in Traditional Khmer

Medicine (TKM), a traditional medicine system in Cambodia that has been practiced for hundreds of years. Cambodia is rich in fauna and flora species, many of which have been, and continue to be, traded domestically for traditional medicine use. Combined with other known exploitative practices, such as snaring for wild meat consumption and international trade in wildlife, domestic trade in wildlife medicine threatens populations of regional conservation importance. Here, we provide an updated understanding about how TKM is practiced in modern times; how TKM practices are transmitted and adapted; and roles of wildlife part remedies in TKM historically and presently. We conducted semi-structured interviews with TKM practitioners in Stung Treng, Mondulkiri Province, and at the National Center for Traditional Medicine in Phnom Penh, the capital of Cambodia. TKM is generally practiced in the private sector and is mostly informal, without enrollment in any academic training. TKM practitioner roles commonly involve collecting, preparing, selling, and advising on medicine, rather than providing direct treatment. Over half of the interviewed TKM practitioners (57.6%) were still prescribing wildlife parts as medicine over the past 5 years, with 28 species of wild animals reported. Lorises and porcupine were the wildlife products cited as being in highest demand in TKM, primarily prescribed for women's illnesses such as post-partum fatigue (Toas and Sawsaye kchey). However, the supply of wildlife products sourced from the wild was reported to have dropped in the 5 years prior to the survey, which represents an opportunity to reduce prescription of threatened wildlife. We suggest that our results be used to inform tailored demand reduction interventions designed to encourage greater reliance on biomedicine and non-threatened plants, particularly in rural areas where use of biomedicine may still be limited.

Hemant Singh

CHINA

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Sherani, S., Perng, L., and Sherani, M. (2022). Evidence of cave lion (Panthera spelaea) from Pleistocene Northeast China. Historical Biology, 35(6), 988-996.
https://doi.org/10.1080/08912963.2022.2071711

The cave lion (Panthera spelaea) was one of the most widespread carnivores in the Pleistocene. The species ranged throughout Eurasia and even into North America as a member of the Mammuthus-Coelodonta fauna. However, the species has not previously been reported from the Mammuthus-Coelodonta fauna from the Pleistocene assemblages of the Songhua River. This study presents evidence of two Panthera spelaea specimens from the Middle and Late Pleistocene Songhua River fossil assemblages (MIS 10–8 and MIS 5–3). A combination of lower population due to vegetation shifts in the region and misidentification of specimens as Panthera tigris may explain why Panthera spelaea has not previously been reported in the region. The Middle Pleistocene specimen displays traits regarded as primitive in European cave lions. The Late Pleistocene specimen displays a mixture of primitive and advanced traits. These traits indicate a morphological transition within the species and also a possible ancestral relationship to Panthera atrox.

Behaviour

Kong, X., Liu, D., Kathait, A., Cui, Y., Wang, Q., Yang, S., Li, X., Gong, M., Roberts, N., Xing, X., and Jiang, G. (2022). Behavioral-psychological motivations encoded in the vocal repertoire of captive Amur tiger (Panthera tigris altaica) cubs. BMC Zoology, 7(1), 2.
https://doi.org/10.1186/s40850-021-00102-9

ABSTRACT

The Amur tiger (Panthera tigris altaica) is the largest and one of the most endangered cats in the world. In wild and captive cats, communication is mainly dependent on olfaction. However, vocal communication also plays a key role between mother and cubs during the breeding period. How cubs express their physiological and psychological needs to their mother and companions by using acoustic signals is little known and mainly hindered by the difficult process of data collection. Here, we quantitatively summarized the vocal repertoire and behavioral contexts of captive Amur tiger cubs. The aim of the present work was to investigate the behavioral motivations of cub calls by considering influential factors of age, sex, and rearing experiences. Results The 5335 high-quality calls from 65 tiger cubs were classified into nine

call types (Ar-1, Ar-2, Er, eee, Chuff, Growl, Hiss, Haer, and Roar) produced in seven behavioral contexts. Except for Er, eight of the nine call types were context-specific, related to Play (Ar-2, eee, and Roar), Isolation (Ar-1), Offensive Context (Haer, Growl, and Hiss), and a friendly context (Chuff). Conclusions The results suggest that cubs are not quiet, but instead they express rich information by emitting various call types, which are probably crucial for survival in the wild. We herein provide the first detailed spectrogram classification to indicate vocal repertoires of calls and their coding with respect to behavioral contexts in Amur tiger cubs, and we pave the steps for revealing their social communication system, which can be applied for conservation of populations. These insights can help tiger managers or keepers to improve the rearing conditions by understanding the feline cubs' inner status and needs by monitoring their vocal information expressions and exchanges.

CONSERVATION, MANAGEMNET AND POLICY RECOMMENDATION

Fong, S. Y. (2022). Modified Traditional Chinese Medicine Formula: Is It Still Effective? Borneo Journal of Medical Sciences (BJMS), 16(3), 1-2. *https://doi.org/10.51200/bjms.v16i3.3887*

ABSTRACT

Traditional Chinese medicine (TCM) is a medical system recorded over 2,000 years ago and it is making a comeback in the 21st century. Basic theories of TCM are based on the Chinese philosophy of Yin-Yang, Qi and the Five Elements (Ma et al., 2021). In TCM, balance and harmony with the environment (nature) are keys to good health and imbalances will lead to illnesses (Cheung et al., 2020). One of the approaches used by TCM practitioners to treat illnesses is the use of natural medicine derived from plants and animals (Ma et al., 2021). In practice, a combination of two or more medicinal materials (known as TCM formulas), having synergistic effects, is often used to achieve optimal therapeutic efficacy, while attenuating toxicity (Zhang et al., 2017). However, some of the materials derived from animal and plant species, such as the rhinoceros (Rhinocerotidae), tiger (Panthera tigris) and caterpillar fungus (Ophiocordyceps sinensis), which are traditionally used, are now endangered (Cheung et al., 2020). Besides, the distribution of some plant species and substances derived from these species, including Ephedra spp. (Ma Huang), Aconitum spp. (Fu Zi and Chuan Wu) and Aristolochia spp. (Mu Tong and Fang Ji) are restricted or banned in some countries due to their toxicity (Fleischer et al., 2017). Therefore, a question arises as to whether the modification of TCM formulas to eliminate these ingredients could affect their therapeutic efficacy.

Han, X., Feng, L., and Ge, J. (2022). Tiger in the Woods, Elephant in the Room: Designing a Forest Management Plan for Amur Tiger (Panthera tigris altaica) Conservation. In P. J. Baker, D. R. Larsen, and A. Saxena (Eds.), Forests as Complex Social and Ecological Systems (pp. 223-251). Managing Forest Ecosystems, vol 41. Springer. *https://doi.org/10.1007/978-3-030-88555-7_11*

ABSTRACT

Forest-related measurements have become widely used in conservation. Established indicators typically measure the extent of forested areas; however, the complex challenges facing wildlife conservation, while further examination of the forest condition itself is much needed to tackle complex problems by applying accumulated knowledge from forest ecology to the practice of wildlife conservation. This study describes an attempt to link forest stand dynamics and wildlife conservation by considering the value of different forest structures in maintaining plant and animal populations and in particular the Amur tiger. We discuss which forest stand structures are associated with Amur tigers and then illustrate a forest management plan focused on promoting habitat for Amur tiger (Panthera tigris altaica) in areas with human settlements. Our study demonstrates the feasibility of managing forest stand structures for Amur tiger conservation outcomes using forest management decision-support tools.KeywordsForest structureManagement planningStand development pathwaysWildlife conservation.

Li, Y., Powell, J., Jin, A., Ryoo, H. K., Li, H., Pandey, P., Zhu, W., Li, D., and Lee, H. (2022). Community attitudes towards Amur tigers (Panthera tigris altaica) and their prey species in Yanbian, Jilin province, a region of northeast China where tigers are returning. PloS One, 17(10), e0276554. *https://doi.org/10.1371/journal.pone.0276554*.

ABSTRACT

Community attitudes towards large carnivores are of central importance to their conservation in human-dominated landscapes. In this study, we evaluate community attitudes and perceptions towards the Amur tiger (Panthera tigris altaica), Amur leopard (Panthera pardus orientalis) and bears (Ursus thibetanus and Ursus arctos), as well as their prey species, namely sika deer (Cervus nippon), roe deer and wild boar (Sus scrofa), in Yanbian Korean Autonomous Prefecture, Jilin province, northeast China. We surveyed 139 households and found that community members' perceptions of large carnivores and their prey species were influenced by their predominant economic activities; their prior interactions with wildlife; their household income level; and whether they were either long-term residents of Yanbian or had migrated to the region from elsewhere in China. We recorded fairly neutral attitudes towards large carnivores among the communities we surveyed, but strongly negative attitudes were shown towards wild boar, particularly where respondents had lost agricultural products to crop raiding by wild boar. We recommend conservation stakeholders in northeast China utilise this finding to encourage support for large carnivore recovery and conservation by targeting

messaging around the importance of the tiger as a key predator of wild boar in the ecosystem. Furthermore, our findings suggest that government provided compensation paid for cattle lost to large carnivore predation (notably, by tigers) may be helping to reduce animosity from cattle owners towards large carnivores. However, we also highlight that compensation for loss of livestock is therefore performing a useful role in mitigating human-wildlife conflict, that there are potentially unintended consequences of the current compensation program, for example it fails to dissuade livestock grazing in protected areas.

Zhou, S., Chen, H., Zhang, Z., Liu, X., Li, W., Liu, D., and Yang, J. (2022). From Amur tiger occurrence in the Greater Khingan Mountains to doing an overall conservation for it in China. Conservation Science and Practice, 4(9), 1-4. *https://doi.org/10.1111/csp2.12770*

ABSTRACT

The Amur Tiger, a critically endangered species, is a Class I Protected Species under China's national legislation and CITES Appendix I. The wild population in Russia Far East is less than 500, and in southeastern China, it is about 20. Northeastern China is crucial for global tiger conservation, and the recent photographic captures of tigers in Hunchun Nature Reserve are positive signs of recovery. Despite being a Class I Endangered Species in China, tigers face threats such as habitat loss, poaching, and human-wildlife conflict. Efforts to protect the Amur Tiger in China include the establishment of the Northeast Tiger and Leopard National Park, which aims to provide a safe place for tigers to roam and bolster their populations. Conservation priorities have been set, including the enlargement of current reserves and the creation of wildlife corridors to maintain the evolutionary potential of Amur tigers facing environmental change.

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Guo, J., Jin, Y., Tian, X., Bao, H., Sun, Y., Gray, T., Song, Y., and Zhang, M. (2022). Diet-induced microbial adaptation process of red deer (Cervus elaphus) under different introduced periods. Frontiers in Microbiology, 13, 1033050. *https://doi.org/10.3389/fmicb.2022.1033050*.

ABSTRACT

Insufficient prey density is a major factor hindering the recovery of Amur tiger (Panthera tigris altaica), and in order to effectively restore the Amur tiger, red deer (Cervus elaphus) were released into the Huangnihe National Nature Reserve of Northeast China as the main reinforcement. Differences in feeding and synergistic changes caused by intestinal microbial community could impact the adaptation of wildlife following reintroductions into field environments. We analyzed the foraging change in shaping the intestinal microbial community of the red deer after being released to Huangnihe National Nature Reserve and screened the key microbial flora of the red deer when processing complex food resources. The feeding and intestinal microbial communities of the red deer were analyzed by plant DNA barcoding sequencing and 16S rRNA high-throughput sequencing respectively. The results showed that there were significant differences in food composition between wild and released groups [released in 2019(R2): n=5; released in 2021(R0): n=6), the wild group fed mainly on Acer (31.8%) and Abies (25.6%), R2 fed mainly on Betula (44.6%), R0 had not formed a clear preferred feeding pattern, but had certain ability to process and adapt to natural foods. Firmicutes (77.47%) and Bacteroides (14.16%) constituted the main bacterial phylum of red deer, of which the phylum Firmicutes was the key species of the introduced red deer for processing complex food resources ($p < 0.05$). The wild release process significantly changed the intestinal microbial structure of the red deer, making it integrate into the wild red deer. The period since release into the wild may be a key factor in reshaping the structure of the microbial community. This study suggested that the intestinal microbial structure of red deer was significantly different dependent upon how long since captive deer has been translocated. Individuals which have lived in similar environments for a long time will have similar gut microbes. This is adaption process of wildlife to natural environment after wild release, taking into account the gut microbes, the feeding changes in shaping microbial communities can help introduced red deer match complex food resources and novel field environments.

ZOOLOGY AND ANIMAL WELFARE

Ren, H., Yang, L., Zhu, N., Li, J., Su, C., Jiang, Y., and Yang, Y. (2022). Additional evidence of tigers (Panthera tigris altaica) as intermediate hosts for Toxoplasma gondii through the isolation of viable strains. International Journal for Parasitology. Parasites and Wildlife, 19, 330-335. *https://doi.org/10.1016/j.ijppaw.2022.11.009*.

ABSTRACT

Toxoplasmosis is one of the most common zoonotic diseases in the world. Felines excrete Toxoplasma gondii oocysts, which play a key role in the transmission of this protozoon. Pathological diagnoses were performed on four carcasses of captive tigers collected from 2019 to 2021 in China, and T. gondii was surveyed using serology, molecular analysis, and aetiology. Striated muscle samples of the tigers (n = 4) were bioassayed in mice. DNA derived from T. gondii tachyzoites was isolated and characterized using PCR–RFLP. The pathological diagnoses revealed that ageing, declined immune function, liver, and kidney failures caused the deaths in the tigers examined. A modified agglutination test (cut–off: 1:25) revealed that IgG antibodies to T. gondii were 100% (4/4) in the captive tigers. Two viable T. gondii strains

(TgTigerCHn3 and TgTigerCHn4) were isolated from tiger striated muscles and seeded on the Vero cell culture for further propagation. The genotypes of TgTigerCHn3 and TgTigerCHn4 were ToxoDB#20 and ToxoDB#2, respectively. The two strains were avirulent for Swiss mice, which matched the ROP18 and ROP5 gene alleles of TgtigerCHn3 (3/4) and TgtigerCHn4 (3/3). Few brain tissue cysts (0–213) were observed in the mice after inoculation with TgTigerCHn3 and TgTigerCHn4. This is the first documented isolation of T. gondii ToxoDB#20 and ToxoDB#2 from tigers. The results provide additional direct evidence of tiger as intermediate hosts for Toxoplasma gondii. Tigers in the zoos may potentially transmit T. gondii to other animals and humans.

Zhang, X., Liao, Y., Qin, T., Ma, J., Liu, J., Zou, J., Huang, H., Zhong, X., and Yang, M. (2022). Developmental stage variation in the gut microbiome of South China tigers. Frontiers in Microbiology, 13, 962614. *https://doi.org/10.3389/fmicb.2022.962614*

ABSTRACT

South China tigers (Panthera tigris amoyensis, SC) are the most threatened tiger subspecies in the world. All the living SCs are captive in zoos or reserves and depend on artificial feeding. The composition of the gut microbiome plays an important role in sustaining the health of the host. A comprehensive understanding of the composition and development of the microbial community of SC is helpful to improve the feeding of captive SC. In this study, we collected 47 fecal samples, 37 of which were from SC of three developmental stages, 5 from adult Amur tigers (Am), and 5 from adult Bengal tigers (Bg), which were all housed in the same zoo. We investigated the diversity, richness, and composition of the bacterial microbiomes and we found that the gut microbiome of SC is strongly affected by host aging. The composition of the gut microbiome of juvenile SC experienced dramatic changes from 5 months old to 1 year old, and it showed much less difference when compared to the samples of 1 year old and the subadult. No significant differences were observed between the samples of subadult and the adult groups. The predominant phylum of 5-month-old SC is Fusobacteriota (33.99%) when the juvenile tigers were older than 5 months, and Firmicutes, but not Fusobacteriota, became the predominant phylum of bacteria in their gut. The gut microbiome of SC, Am, and Bg is possibly affected by their genetic variation; however, the core microbiome of these three subspecies is the same. Our data suggest that the gut microbiome of SC undergoes a developmental progression: a developmental phase (cub), a transitional phase (subadult), and a stable phase (adult). These results expand our understanding of the role of age in the development of the gut microbiome of SC.

GENETICS

Baeza, J. A. (2022). Mitochondrial genomes assembled from non-invasive eDNA metagenomic scat samples in the endangered Amur tiger (Panthera tigris altaica). PeerJ, 10, e14428. *https://doi.org/10.7717/peerj.14428*.

ABSTRACT

The Amur or Siberian tiger Panthera tigris altaica (Temminck, 1844) is currently restricted to a small region of its original geographical range in northwestern Asia and is considered 'endangered' by the IUCN Red List of Threatened Species. This solitary, territorial, and large top predator is in major need of genomic resources to inform conservation management strategies. This study formally tested if complete mitochondrial genomes of P. tigris altaica can be assembled from non-enriched metagenomic libraries generated from scat eDNA samples using the Illumina sequencing platform and open-access bioinformatics pipelines. The mitogenome of P. tigris altaica was assembled and circularized using the pipeline GetOrganelle with a coverage ranging from 322.7x to 17.6x in four different scat eDNA samples. A nearly complete mitochondrial genome (101x) was retrieved from a fifth scat eDNA sample. The complete or nearly complete mitochondrial genomes of P. tigris altaica were AT-rich and composed of 13 protein coding genes (PCGs), 22 transfer RNA genes, two ribosomal RNA genes, and a putative control region. Synteny observed in all assembled mitogenomes was identical to that reported before for P. tigris altaica and other felids. A phylogenomic analysis based on all PCGs demonstrated that the mitochondrial genomes assembled from scat eDNA reliably identify the sequenced samples as belonging to P. tigris and distinguished the same samples from closely and distantly related congeneric species. This study demonstrates that it is viable to retrieve accurate whole and nearly complete mitochondrial genomes of P. tigris altaica (and probably other felids) from scat eDNA samples without library enrichment protocols and using open-access bioinformatics workflows. This new genomic resource represents a new tool to support conservation strategies (bio-prospecting and bio-monitoring) in this iconic cat.

Chiu, H.-C., Sun, X., Bao, Y., Fu, W., Lin, K., Chen, T., Zheng, C., Li, S., Chen, W., and Huang, C. (2022). Molecular identification of Colpodella sp. of South China tiger (Panthera tigris amoyensis [Hilzheimer]) in the Meihua Mountains, Fujian, China. Folia Parasitologica, 69, 2022.019.
http://dx.doi.org/10.14411/fp.2022.019.

ABSTRACT

A three-year-old male South China tiger died in the tiger enclosure of the China Tiger Park in the

Meihua Mountains on December 2018 after being bitten by a tick. This tiger presented clinical symptoms like whole-body severe jaundice, hepatosplenomegaly, kidney, and lymph node hemorrhages. The Colpodella sp.-specific 18S rRNA gene was detected using nested PCR. Interestingly, the DNA isolated from the blood of the tiger was found to be 100% similar to that of the tick by NCBI BLAST analysis. However, the DNA fragments isolated from the tiger's blood were 90.1% similar to the Colpodella sp. strain human erythrocyte parasite (HEP, MH208621) and 90.4% similar to the Colpodella sp. strain Heilongjiang (HLJ, KT364261). To investigate the species of ticks and ticks-carried Colpodella parasites in this region, the species of ticks obtained from the grasses outside the tiger enclosure and the species of Colpodella carried by ticks were identified. The DNA from ticks as well as that from the tick-borne Colpodella sp. were amplified from each tick using PCR followed by amplicon sequencing. In total 402 adult ticks samples were collected, among which 22 were positive for Colpodella sp. (5.5%), and the species were further determined by morphology, DNA sequencing and phylogenetic analyses. Interestingly, one Colpodella sp. was found to have 94.2% sequence similarities to the Colpodella sp. strain HEP (MH208621). This strain was previously reported to infect a woman in Yunnan, China. In addition, three Colpodella sp. showed 87-91% sequence similarities to the Colpodella sp. strain HLJ (KT364261), which was previously reported to infect human in Heilongjiang, China. This study disclosed the possibility of zoonotic transmission of Colpodella sp. by ticks in China. Finally, it provides a basis for urgently determining and monitoring the repertoire of ticks-borne piroplasmid pathogens, with the ultimate aim of strategic control.

Du, H., Yu, J., Li, Q., and Zhang, M. (2022). New Evidence of Tiger Subspecies Differentiation and Environmental Adaptation: Comparison of the Whole Genomes of the Amur Tiger and the South China Tiger. Animal, 12(14), 1817. *https://doi.org/10.3390/ani12141817*.

ABSTRACT

Panthera tigris is a top predator that maintains the integrity of forest ecosystems and is an integral part of biodiversity. No more than 400 Amur tigers (P. t. altaica) are left in the wild, whereas the South China tiger (P. t. amoyensis) is thought to be extinct in the wild, and molecular biology has been widely used in conservation and management. In this study, the genetic information of Amur tigers and South China tigers was studied by whole-genome sequencing (WGS). A total of 647 Gb of high-quality clean data was obtained. There were 6.3 million high-quality single-nucleotide polymorphisms (SNPs), among which most (66.3%) were located in intergenic regions, with an average of 31.72% located in coding sequences. There were 1.73 million insertion-deletions (InDels), among which there were 2438 InDels (0.10%) in the coding region, and 270 thousand copy number variations (CNVs). Significant genetic differences were found between the Amur tiger and the South China tiger based on a principal component analysis and phylogenetic tree. The linkage disequilibrium analysis showed that the linkage

disequilibrium attenuation distance of the South China tiger and the Amur tiger was almost the same, whereas the r2 of the South China tiger was 0.6, and the r2 of the Amur tiger was 0.4. We identified functional genes and regulatory pathways related to reproduction, disease, predation, and metabolism and characterized functional genes related to survival in the wild, such as smell, vision, muscle, and predatory ability. The data also provide new evidence for the adaptation of Amur tigers to cold environments. PRKG1 is involved in temperature regulation in a cold climate. FOXO1 and TPM4 regulate body temperature to keep it constant. Our results can provide genetic support for precise interspecies conservation and management planning in the future.

Hu, J., Westbury, M. V., Yuan, J., Wang, C., Xiao, B., Chen, S., Song, S., Wang, L., Lin, H., Lai, X., and Sheng, G. (2022). An extinct and deeply divergent tiger lineage from northeastern China recognized through palaeogenomics. Proceedings of the Royal Society B, 289, 20220617. *https://doi.org/10.1098/rspb.2022.0617*.

ABSTRACT

Tigers (Panthera tigris) are flagship big cats and attract extensive public attention due to their charismatic features and endangered status. Despite this, little is known about their prehistoric lineages and detailed evolutionary histories. Through palaeogenomic analyses, we identified a Pleistocene tiger from northeastern China, dated to beyond the limits of radiocarbon dating (greater than 43 500 years ago). We used a simulated dataset and different reads processing pipelines to test the validity of our results and confirmed that, in both mitochondrial and nuclear phylogenies, this ancient individual belongs to a previously unknown lineage that diverged prior to modern tiger diversification. Based on the mitochondrial genome, the divergence time of this ancient lineage was estimated to be approximately 268 ka (95% CI: 187–353 ka), doubling the known age of tigers' maternal ancestor to around 125 ka (95% CI: 88–168 ka). Furthermore, by combining our findings with putative mechanisms underlying the discordant mito-nuclear phylogenetic placement for the South China tigers, we proposed a more complex scenario of tiger evolution that would otherwise be missed using data from modern tigers only. Our study provides the first glimpses of the genetic antiquity of tigers and demonstrates the utility of aDNA-based investigation for further understanding tiger evolution.

Zhang, L., Lan, T., Lin, C., Fu, W., Yuan, Y., Lin, K., Li, H., Sahu, S. K., Liu, Z., Chen, D., Liu, Q., Wang, A., Wang, X., Ma, Y., Li, S., Zhu, Y., Wang, X., Ren, X., Lu, H., Huang, Y., Yu, J., Liu, B., Wang, Q., Zhang, S., Xu, X., Yang, H., Liu, D., Liu, H., and Xu, Y. (2022). Chromosome-scale genomes reveal genomic consequences of inbreeding in the South China tiger: A comparative study with the Amur tiger. Molecular Ecology Resources, 23(2), 330-347. *https://doi.org/10.1111/1755-0998.13669*.

ABSTRACT

The South China tiger (Panthera tigris amoyensis, SCT) is the most critically endangered subspecies of tiger due to functional extinction in the wild. Inbreeding depression is observed among the captive population descended from six wild ancestors, resulting in high juvenile mortality and low reproduction. We assembled and characterized the first SCT genome and an improved Amur tiger (P. t. altaica, AT) genome named AmyTig1.0 and PanTig2.0. The two genomes are the most continuous and comprehensive among any tiger genomes yet reported at the chromosomal level. By using the two genomes and resequencing data of 15 SCT and 13 AT individuals, we investigated the genomic signature of inbreeding depression of the SCT. The results indicated that the effective population size of SCT experienced three phases of decline, ~5.0–1.0 thousand years ago, 100 years ago, and since captive breeding in 1963. We found 43 long runs of homozygosity fragments that were shared by all individuals in the SCT population and covered a total length of 20.63% in the SCT genome. We also detected a large proportion of identical-by-descent segments across the genome in the SCT population, especially on ChrB4. Deleterious nonsynonymous single nucleotide polymorphic sites and loss-of-function mutations were found across genomes with extensive potential influences, despite a proportion of these loads having been purged by inbreeding depression. Our research provides an invaluable resource for the formulation of genetic management policies for the South China tiger such as developing genome-based breeding and genetic rescue strategy.

Medicine

Shen, Y., Wang, N., Zhang, Q., Liu, Y., Wu, Q., He, Y., Wang, Y., Wang, X., Zhao, Q., Zhang, Q., Qin, L., and Zhang, Q. (2022). Jin-Tian-Ge ameliorates ovariectomy-induced bone loss in rats and modulates osteoblastogenesis and osteoclastogenesis in vitro. Chinese Medicine, 17(1), 78. *https://doi.org/10.1186/s13020-022-00627-2*.

ABSTRACT

Background: Tiger bone, which had been one of the most famous traditional Chinese medicine for 2000 years, was originate from the skeleton of Panthera tigris L., and had the actions of anti-inflammatory, analgesic, immune-regulatory and promoting healing of bone fracture, and was used for the treatment of osteoporosis and rheumatoid arthritis. Jin-Tian-Ge (JTG), the artificial tiger bone powder, were prepared from skeletons of several farmed animals to substitute the natural tiger bone, and has been used for the treatment of osteoporosis in clinical practice. However, the characteristic and mechanism of action of JTG for the therapy of osteoporosis need to be further evidenced by using modern pharmacological methods. The aim of this work is to investigate the bone-protective effects of JTG, and explore the possible underlying mechanism. Methods: Ovariectomy (OVX) rats were orally administrated JTG or estradiol valerate (EV) for 12 weeks. We investigated the pharmacodynamic effects of JTG on anti-bone loss in OVX rats, and also investigated the role of JTG in promoting osteogenesis and inhibiting osteoclast differentiation. Results: JTG increased the bone mineral density (BMD), improved the bone microarchitecture and biomechanical properties in ovariectomized rast, whereas reversed the bone high turnover in OVX rats as evidenced by serum biochemical markers in OVX rats. JTG increased osteogenic differentiation of BMSCs in vitro, and up-regulated the expression of the key proteins of BMP and Wnt/β-catenin pathways. JTG also inhibited the osteoclastogenesis of BMM as evidenced by the alteration of the TRAP activity, F-actin construction and the expression of nuclear factor of activated T-cells cytoplasmic 1 (NFATc1), c-Fos, Cathepsin K (Ctsk) and matrix metallopeptidase 9 (MMP9) of OCs induced with RANKL and LPS, reduced the expression and phosphorylation of NF-κB in OCs. Conclusions: JTG prevented bone loss in OVX rats and increased osteogenic differentiation of BMSCs through regulation of the BMP and Wnt/β-catenin pathway, inhibited osteoclastogenesis by suppressing the NF-κB pathway, suggesting that JTG had the potentials for prevention and treatment of osteoporosis by modulating formation and differentiation of osteoblast and osteoclast.

MONITORING AND ASSESSMENT

Du, H., Xiaoliang, Z., Zhang, M., Xiangdong, R., and Lee, T. M. (2022). Spatial Distribution and Conservation Strategies of Large Carnivores in Human-Dominated Landscape: A Case Study of Asiatic Black Bear in Jilin, China. Frontiers in Ecology and Evolution, 10, 882282. *https://doi.org/10.3389/fevo.2022.882282*.

ABSTRACT

Large carnivores maintain the balance of ecosystems. Understanding distribution and population changes are necessary prerequisites for scientific conservation strategy. The east of Jilin Province is the habitat of endangered Amur tiger (Panthera tigris altaica). The Chinese government has focused the monitoring on protecting the Amur tiger. However, little is known about Asiatic black bear (ABB, Ursus thibetanus) distribution, population dynamics in the wild, and protection awareness of local residents in Jilin Province, China. We conducted a integrative survey in mountain areas of eastern Jilin to determine ABB distribution. We explored the drivers of the distribution of ABB in Jilin using logstic regression, we further predicted the habitat suitability and potential suitable habitat of the ABB. Totally, we surveyed 112 grids (15 km × 15 km) from November 2015 to January 2019. Logistic regression analysis revealed that the main factors driving ABB distribution in Jilin are forest coverage, distance from protected areas, distance from main roads (railways and highways), and distance from water bodies.

The results of questionnaire survey showed that the local residents' understanding of ABB distribution is congruent with our field research. They believed that the number of ABBs has gradually increased in the past ten years. Nevertheless, the local residents have a negative attitude toward the ABBs, which may adversely affect efforts to protect them, possibly leading to more conflicts between humans and bears. Therefore, there is a need to consider ways to change the attitude of the locals through the strengthening of the protection propaganda and advocating management as being critical for the protection of ABBs. Our research provides a scientific basis for future conservation planning. We recommend taking local people's attitude into consideration during conservation management strategy making to reduce human-bear conflicts and promote the coexistence of humans and bears.

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Sun, X., Liu, Y.-C., Tiunov, M. P., Gimranov, D. O., Zhuang, Y., Han, Y., Driscoll, C. A., Pang, Y.-H., Li, C., Pan, Y., Velasco, M. S., Gopalakrishnan, S., Yang, R.-Z., Li, B.-G., Jin, K., Xu, X., Uphyrkina, O., Huang, Y.-Y., Wu, X.-H., Gilbert, M. T. P., O'Brien, S. J., Yamaguchi, N., and Luo, S.-J. (2022). Ancient DNA Reveals China as a Historical Genetic Melting Pot in Tiger Evolution. Nat Ecol Evol, 7, 1914–1929. *https://doi.org/10.1101/2022.09.14.507899*.

ABSTRACT

The tiger (Panthera tigris) is a charismatic megafauna species that originated and diversified in Asia and probably experienced population contraction and expansion during the Pleistocene, resulting in low genetic diversity of modern tigers. However, little is known about patterns of genomic diversity in ancient populations. Here we generated whole-genome sequences from ancient or historical (100–10,000 yr old) specimens collected across mainland Asia, including a 10,600-yr-old Russian Far East specimen (RUSA21, 8× coverage) plus six ancient mitogenomes, 14 South China tigers (0.1–12×) and three Caspian tigers (4–8×). Admixture analysis showed that RUSA21 clustered within modern Northeast Asian phylogroups and partially derived from an extinct Late Pleistocene lineage. While some of the 8,000–10,000-yr-old Russian Far East mitogenomes are basal to all tigers, one 2,000-yr-old specimen resembles present Amur tigers. Phylogenomic analyses suggested that the Caspian tiger probably dispersed from an ancestral Northeast Asian population and experienced gene flow from southern Bengal tigers. Lastly, genome-wide monophyly supported the South China tiger as a distinct subspecies, albeit with mitochondrial paraphyly, hence resolving its longstanding taxonomic controversy. The distribution of mitochondrial haplogroups corroborated by biogeographical modelling suggested that Southwest China was a Late Pleistocene refugium for a relic basal lineage. As suitable habitat returned, admixture between divergent lineages of South China tigers took place in Eastern China, promoting the evolution of other northern subspecies. Altogether, our

analysis of ancient genomes sheds light on the evolutionary history of tigers and supports the existence of nine modern subspecies.

SUSTAINABLE SOLUTION AND TECHNOLOGY

Shi, C., Xu, J., Roberts, N. J., Liu, D., and Jiang, G. (2022). Individual automatic detection and identification of big cats with the combination of different body parts. Integrative Zoology, 18(1), 157-168. *https://doi.org/10.1111/1749-4877.12641*.

ABSTRACT

The development of facial recognition technology has become an increasingly powerful tool in wild animal individual recognition. In this paper, we develop an automatic detection and recognition method with the combinations of body features of big cats based on the deep convolutional neural network (CNN). We collected dataset including 12 244 images from 47 individual Amur tigers (Panthera tigris altaica) at the Siberian Tiger Park by mobile phones and digital camera and 1940 images and videos of 12 individual wild Amur leopard (Panthera pardus orientalis) by infrared cameras. First, the single shot multibox detector algorithm is used to perform the automatic detection process of feature regions in each image. For the different feature regions of the image, like face stripe or spots, CNNs and multi-layer perceptron models were applied to automatically identify tiger and leopard individuals, independently. Our results show that the identification accuracy of Amur tiger can reach up to 93.27% for face front, 93.33% for right body stripe, and 93.46% for left body stripe. Furthermore, the combination of right face, left body stripe, and right body stripe achieves the highest accuracy rate, up to 95.55%. Consequently, the combination of different body parts can improve the individual identification accuracy. However, it is not the higher the number of body parts, the higher the accuracy rate. The combination model with 3 body parts has the highest accuracy. The identification accuracy of Amur leopard can reach up to 86.90% for face front, 89.13% for left body spots, and 88.33% for right body spots. The accuracy of different body parts combination is lower than the independent part. For wild Amur leopard, the combination of face with body spot part is not helpful for the improvement of identification accuracy. The most effective identification part is still the independent left or right body spot part. It can be applied in long-term monitoring of big cats, including big data analysis for animal behavior, and be helpful for the individual identification of other wildlife species.

ZOOLOGY AND ANIMAL WELFARE

Chen, L., Xu, D., Sun, M., Li, Y., Wang, S., Gao, Y., Gao, Z., and Shi, Y. (2022). The effect of environment on intestinal microbial diversity of Panthera animals may exceed genetic

relationship. Frontiers in Microbiology, 13, 938900. https://doi.org/10.3389/fmicb.2022.938900.

ABSTRACT

Intestinal microbes are important symbiotes in the gastrointestinal tract of mammals, which are affected by food, environment, climate, genetics, and other factors. The gut microbiota of felines has been partially studied, but a comprehensive comparison of the gut microbiota of Panthera species was less reported. In this study, we compared the gut microbial composition and diversity of five species of Panthera (Panthera tigris, Panthera leo, Panthera onca, Panthera pardus, and Panthera uncia) by 16S ribosomal RNA (rRNA) amplicon sequencing. The results showed that Firmicutes was the most abundant phylum among all the Panthera species, followed by Actinobacteria, Fusobacteria, Bacteroidetes, Proteobacteria, Acidobacteria, Verrucomicrobia, Gemmatimonadetes, and Euryarchaeota. There were significant differences in observed species of fecal microbiota among different Panthera animals ($P < 0.05$), indicating that there is species specificity among Panthera fecal microbiota. When the samples were further grouped according to sampling locations, the comparison of the alpha diversity index between groups and beta diversity analysis showed that there were significant differences in the fecal microflora of animals from different sampling locations. Cluster analysis showed that fecal microbes of animals from the same sampling location were clustered, while gut microbes of animals of the same species, but from different sampling locations, were separated. These results indicate that environment may have more influence on mammals' fecal microbial diversity than genetic relationships.

Liu, H., Deng, L., Xu, H., Lu, Y., Tian, L., Chai, H., Liu, Q., Wang, Y., Zhou, X., and Hou, Z. (2022). Seroprevalence and risk factor analysis of Toxoplasma gondii infection in Siberian tigers (Panthera tigris altaica) and giant pandas (Ailuropoda melanoleuca) in China. Parasitology Research, 122(2), 493-496. https://doi.org/10.1007/s00436-022-07747-6.

ABSTRACT

Toxoplasmosis, caused by Toxoplasma gondii, is a worldwide zoonosis. The aim of the present study was to detect the seroprevalence of T. gondii infection and associated risk factors among Siberian tigers (Panthera tigris altaica) and giant pandas (Ailuropoda melanoleuca) in China. Blood samples from 112 Siberian tigers and 22 giant pandas were tested for immunoglobulin G (IgG) against T. gondii by enzyme-linked immunosorbent assay (ELISA). The seroprevalence of T. gondii infection was 7.14% among Siberian tigers and 9.09% among giant pandas. No risk factors were found to be significantly associated with seroprevalence ($P > 0.05$). This is the first study to evaluate T. gondii infection in Siberian tigers on a large scale in China, and it also updates the information regarding the positivity rate of T. gondii infection among giant pandas

in China.

Liu, E., Ma, L., Huang, S., You, D., Guo, L., Li, X., Xu, H., Liu, D., Chai, H., and Wang, Y. (2022). The first feline immunodeficiency virus from Siberian tigers (Panthera tigris altaica) in northeastern China. Archives of Virology, 167(2), 545-551. https://doi.org/10.1007/s00705-022-05370-5.

ABSTRACT

Feline immunodeficiency virus (FIV) naturally infects more than 20 kinds of felines and poses a serious threat to their health, but there has been little research on FIV in tigers. In this study, 320 captive Siberian tigers (225 from Harbin, 55 from Hailin, and 40 from Shenyang) were tested for FIV by nested PCR, and three Siberian tigers from Hailin were FIV positive (5.45%). From these three animals, FIV gene fragments, gag-p26 (444 nt) from samples HD094 and HD1786 and pol-RT (576 nt) and pol-RNase (730 nt) from sample HD631, were sequenced and found to share more than 99% sequence identity with FIV subtype A from domestic cats. This is the first time FIV has been detected in Siberian tigers in China.

Yang, D., Wang, S., Sun, E., Chen, Y., Hua, L., Wang, X., Zhou, R., Chen, H., Peng, Z., and Wu, B. (2022). A temperate Siphoviridae bacteriophage isolate from Siberian tiger enhances the virulence of methicillin-resistant Staphylococcus aureus through distinct mechanisms. Virulence, 13(1), 137-148. https://doi.org/10.1080/21505594.2021.2022276.

ABSTRACT

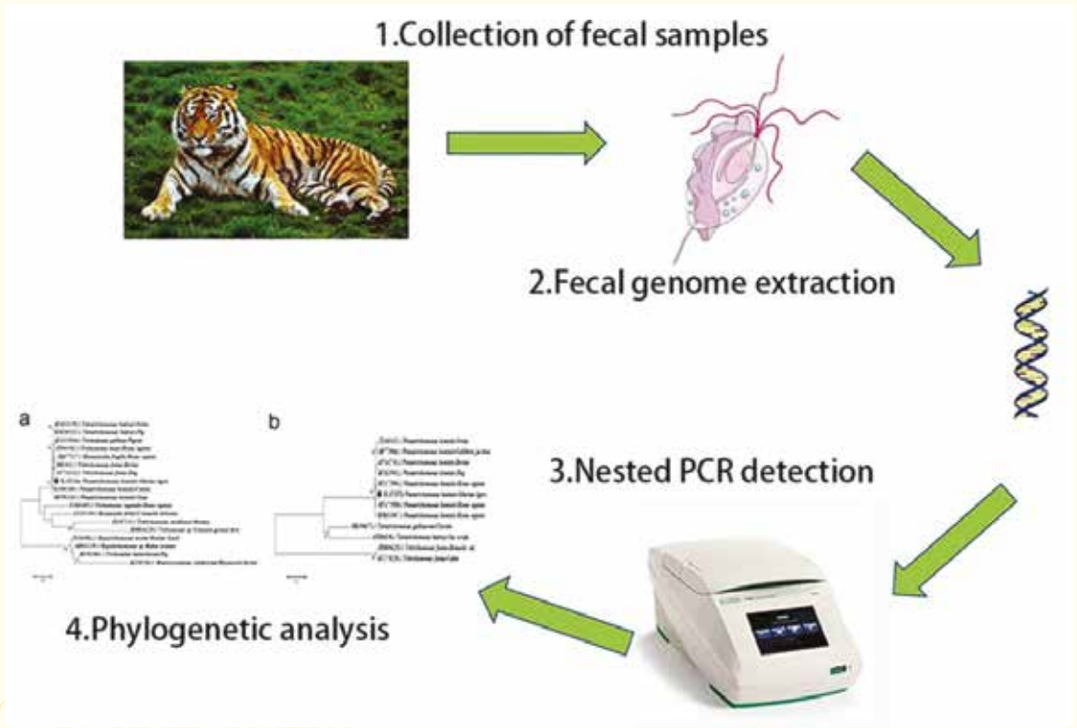
The emergence and worldwide spread of Methicillin-resistant Staphylococcus aureus (MRSA) pose a threat to human health. While bacteriophages are recognized as an effective alternative to treat infections caused by drug resistant pathogens, some bacteriophages in particular the temperate bacteriophage may also influence the virulence of the host bacteria in distinct ways. In this study, we isolated a bacteriophage vB_Saus_PHB21 from an epidermal sample of Siberian tiger (Panthera tigris altaica) using an MRSA strain SA14 as the indicator. Our following laboratory tests and whole genome sequencing analyses revealed that vB_Saus_PHB21 was a temperate bacteriophage belonging to the Siphoviridae family, and this bacteriophage did not contain any virulence genes. However, the integration of PHB21 genome into the host MRSA increased the bacterial capacities of cell adhesion, anti-phagocytosis, and biofilm formation. Challenge of the lysogenic strain (SA14+) caused severe mortalities in both Galleria mellonella and mouse models. Mice challenged with SA14+ showed more serious organ lesions and produced higher inflammatory cytokines (IL-8, IFN-γ and TNF-α) compared to those challenged with SA14. In mechanism, we found the integration of PHB21 genome caused the upregulated expression of many genes encoding products involved in bacterial biofilm formation, adherence

to host cells, anti-phagocytosis, and virulence. This study may provide novel knowledge of "bacteria-phage-interactions" in MRSA.

Zhang, H., Zhang, N., Gong, P., Cheng, S., Wang, X., Li, X., Hou, Z., Liu, C., Bi, T., Wang, B., Cheng, Y., Li, J., and Zhang, X. (2022). Prevalence and molecular characterization of Pentatrichomonas hominis in Siberian tigers (Panthera tigris altaica) in northeast China. Integrative Zoology, 17(4), 543-549. *https://doi.org/10.1111/1749-4877.12629*.

ABSTRACT

The overall infection rate of Pentatrichomonas hominis in Siberian tigers in northeast China is 31.3%. All the P. hominis identified in Siberian tigers belonged to genotype CC1.



GENETICS

Huang, S., Li, X., Xie, W., Guo, L., You, D., Xu, H., Liu, D., Wang, Y., Hou, Z., Zeng, X., Yang, S., Chai, H., and Wang, Y. (2022). Molecular Detection of Parvovirus in Captive Siberian Tigers and Lions in Northeastern China From 2019 to 2021. Frontiers in Microbiology, 13, 898184. *https://doi.org/10.3389/fmicb.2022.898184*.

ABSTRACT

The fact that wild felines are carriers of pernicious infectious viruses should be a major concern due to the potential cross-species transmission between the felines and human or domestic animals. However, studies on the virus in the captive wild felines, especially in tigers, are thin on the ground. In this study, we screened four infectious viruses, namely, feline parvovirus (FPV), feline coronavirus (FCoV), canine distemper virus (CDV), and influenza A virus (IAV), in the blood samples of 285 captive Siberian tigers (Panthera tigris altaica) and in the spleen samples of two deceased lions (Panthera leo), which were collected from 2019 to 2021 in three Siberian Tiger Parks from the northeast of China. Nucleic acids isolated from the blood samples collected from tigers and the spleen samples collected from two deceased lions were positive for FPV by PCR, and the positive rate was 4.6% (13/285) in tigers. Furthermore, the VP2 gene of FPV was amplified by nested PCR, and the sequences of the VP2 gene from these six FPV positive strains shared 98.3–99.9% homology with the reference. The key amino acid sites of VP2 protein were consistent with that of FPV reference strains. Phylogenetic analysis based on the VP2 gene showed that in this study, FPV-positive strains were grouped within the FPV clade and closely related to the Asian strains clade. The results of this study showed that FPV circulated in the captive Siberian tigers and lions in northeastern China and provided valuable information for the study of FPV epidemiology in wild felines. Therefore, we suggest that regular antibody monitoring and booster immunization for tigers should be performed.

GLOBAL

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Anatomy

Dunn, R. H., Beresheim, A., Gubatina, A., Bitterman, K., Butaric, L., Bejes, K., Kennedy, S., Markham, S., Miller, D., Mrvoljak, M., Roge-Jones, L., Stumpner, J., Walter, C., and Meachen, J. A. (2022). Muscular anatomy of the forelimb of tiger (Panthera tigris). Journal of Anatomy, 241(1), 119-144. *https://doi.org/10.1111/joa.13636*.

ABSTRACT

Dissection reports of large cats (family Felidae) have been published since the late 19th century. These reports generally describe the findings in words, show drawings of the dissection, and usually include some masses of muscles, but often neglect to provide muscle maps showing the precise location of bony origins and insertions. Although these early reports can be highly useful, the absence of visual depictions of muscle attachment sites makes it difficult to compare muscle origins and insertions in living taxa and especially to reconstruct muscle attachments in fossil taxa. Recently, more muscle maps have been published in the primary literature, but those for large cats are still limited. Here, we describe the muscular anatomy of the forelimb of the tiger (Panthera tigris), and compare muscle origins, insertions, and relative muscle masses to other felids to identify differences that may reflect functional adaptations. Our results reiterate the conservative nature of felid anatomy across body sizes and behavioral categories. We find that pantherines have relatively smaller shoulder muscle masses, and relatively larger muscles of the caudal brachium, pronators, and su-pinators than felines. The muscular anatomy of the tiger shows several modifications that may reflect an adaptation to terrestrial locomotion and a preference for large prey. These include in general a relatively large m. supraspinatus (shoulder flexion), an expanded origin for m. triceps brachii caput longum, and relatively large m. triceps brachii caput laterale (elbow extension), as well as relatively large mm. brachioradialis, abductor digiti I longus, and abductor digiti V. Muscle groups that are well developed in scansorial taxa are not well developed in the tiger, including muscles of the cranial compartment of the brachium and antebrachium, and m. anconeus. Overall, the mus-culature of the tiger strongly resembles that of the lion (Panthera leo), another large-bodied terrestrial large-prey specialist.

2022

Biology

Michaud, M., Toussaint, S. L. D., and Gilissen, E. (2022). The impact of environmental factors on the evolution of brain size in carnivorans. Communications Biology, 5(1), 998. *https://doi.org/10.1038/s42003-022-03748-4*.

ABSTRACT

The reasons why some animals have developed larger brains has long been a subject of debate. Yet, it remains unclear which selective pressures may favour the encephalization and how it may act during evolution at different taxonomic scales. Here we studied the patterns and tempo of brain evolution within the order Carnivora and present large-scale comparative analysis of the effect of ecological, environmental, social, and physiological variables on relative brain size in a sample of 174 extant carnivoran species. We found a complex pattern of brain size change between carnivoran families with differences in both the rate and diversity of encephalization. Our findings suggest that during carnivorans' evolution, a trade-off have occurred between the cognitive advantages of acquiring a relatively large brain allowing to adapt to specific environments, and the metabolic costs of the brain which may constitute a disadvantage when facing the need to colonize new environments.

History and Culture

Chatar, N., Michaud, M., and Fischer, V. (2022). Not a jaguar after all? Phylogenetic affinities and morphology of the Pleistocene felid Panthera gombaszoegensis. Papers in Palaeontology, 8(5), e1464. *https://doi.org/10.1002/spp2.1464*.

ABSTRACT

Panthera gombaszoegensis is a fossil pantherine from the Pleistocene of Eurasia. It has been considered to be the closest ancestor the jaguar (Panthera onca) due to dental similarities, and has even sometimes been considered to be a subspecies of jaguar. However, our knowledge of this taxon is limited by the scarcity of cranial remains, which has made it difficult to properly assess the phylogenetic affinities and possible ecological role of this taxon. Here, we describe a new cranium of P. gombaszoegensis from Belgium, and present a morphometric analysis of the cranium and dentition of extinct and extant pantherines. Whereas the lower dentition of P. gombaszoegensis is similar to that of P. onca, similarities were not recovered in other parts of the skull. Some cranial traits of P. gombaszoegensis resemble those of other pantherines, especially larger species such as the tiger (P. tigris), while some similarities to taxa such as tiger (P. tigris), lion (P. leo) and leopard (P. pardus) in the skull of P. gombaszoegensis suggest a

diet adapted to a wide prey spectrum. The first ever assessment of the phylogenetic placement of P. gombaszoegensis places this taxon closer to P. tigris than to P. onca, which considerably simplifies the biogeographic history of pantherines.

Jacobs, M. H., Dubois, S., Hosaka, T., Ladanović, V., Muslim, H. F. M., Miller, K. K., Numata, S., Ranaweerage, E., Straka, T. M., Weston, M. A., and Abidin, Z. A. Z. (2022). Exploring cultural differences in wildlife value orientations using student samples in seven nations. Biodiversity and Conservation, 31(3), 757-777. *https://doi.org/10.1007/s10531-022-02361-5*.

ABSTRACT

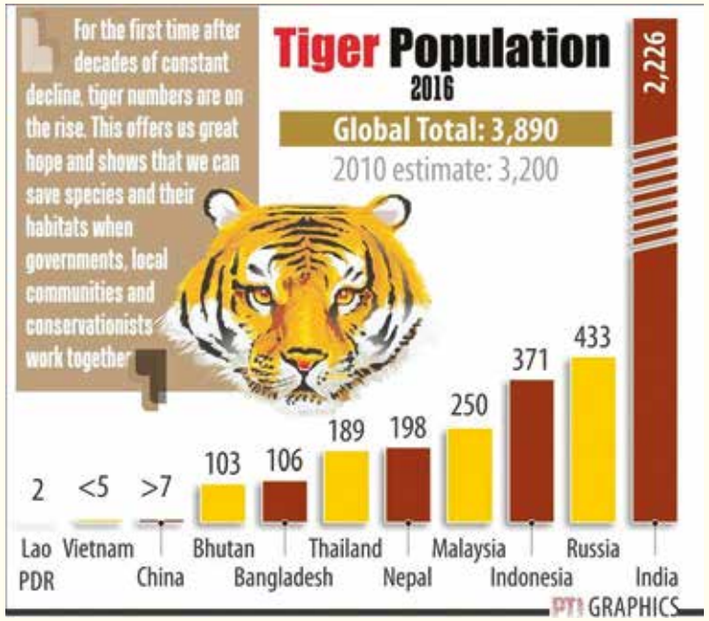
Understanding differences in the way people think about wildlife across countries is important as many conservation challenges transcend jurisdictions. We explored differences in wildlife value orientations in seven countries: Australia, Canada, Germany, Japan, Malaysia, the Netherlands and Serbia. Standard scales assessed domination (prioritizing human well-being) and mutualism (striving for egalitarian relationships with wildlife). We used student samples (total n = 2176) for cross-cultural comparisons. Reliabilities of the wildlife value orientations scales were adequate in all countries. Relationships between demographics and wildlife value orientations were different across countries. Men were generally more oriented towards domination and less towards mutualism than women, except in Serbia, where it was the other way around. Estimated at the level of the individual (using ANOVA), wildlife value orientations varied across countries, with nationality explaining a larger portion of the variation in mutualism (21%) than domination (6%). Estimated at the level of countries (using multilevel modelling), effect sizes were comparable. Thought about wildlife has previously only been examined within single countries. This paper makes a new contribution to the conservation literature suggesting that wildlife value orientations vary by country, and are associated with demographic factors. For conservation practices, understanding national differences in the way people think about wildlife is crucial to understanding sources of conflict among practitioners. Such knowledge is also important to gain public support for conservation.

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATIONS

Ingeman, K. E., Zhao, L. Z., Wolf, C., Williams, D. R., Ritger, A. L., Ripple, W. J., Kopecky, K. L., Dillon, E. M., DiFiore, B. P., Curtis, J. S., Csik, S. R., Bui, A., and Stier, A. C. (2022). Glimmers of hope in large carnivore recoveries. Scientific Reports, 12(1), 10005. *https://doi.org/10.1038/s41598-022-13671-7*.

ASBTRACT

In the face of an accelerating extinction crisis, scientists must draw insights from successful conservation interventions to uncover promising strategies for reversing broader declines. Here, we synthesize cases of recovery from a list of 362 species of large carnivores, ecologically important species that function as terminal consumers in many ecological contexts. Large carnivores represent critical conservation targets that have experienced historical declines as a result of direct exploitation and habitat loss. We examine taxonomic and geographic variation in current extinction risk and recovery indices, identify conservation actions associated with positive outcomes, and reveal anthropogenic threats linked to ongoing declines. We find that fewer than 10% of global large carnivore populations are increasing, and only 12 species (3.3%) have experienced genuine improvement in extinction risk, mostly limited to recoveries among marine mammals. Recovery is associated with species legislation enacted at national and international levels, and with management of direct exploitation. Conversely, ongoing declines are robustly linked to threats that include habitat modification and human conflict. Applying lessons from cases of large carnivore recovery will be crucial for restoring intact ecosystems and maintaining the services they provide to humans.



Illegal Trade

Khanwilkar, S., Sosnowski, M., and Guynup, S. (2022). Patterns of illegal and legal tiger parts entering the United States over a decade (2003–2012). Conservation Science and Practice, 4(e662), 1-15. *https://doi.org/10.1111/csp2.622*.

ABSTRACT

Poaching and illegal trade are primary threats to tigers (Panthera tigris). Trade in tiger parts has been well documented in Asia. However, little is known about tiger parts entering the United States (US). We analyzed seizures of tiger parts trafficked through US ports of entry from 2003 to 2012 along with shipments that had been issued legal Convention on International Trade in Endangered Species import permits. We found 292 seizure incidents and 283 permitted imports over that 10-year period. The amount of tiger parts trafficked into the US illegally was larger than what has been previously reported. Most tiger parts entered the US legally and illegally for personal purposes; 81.8% of seized items were medicinal products. San Francisco, Dallas, and Atlanta were entry hotspots for illegal tiger imports which mainly entered the United States from China and Vietnam. Of the 65.8% of seized parts with a known origin, 99.5% originated from wild tigers. Since country of origin and source of many legally and illegally traded tiger parts was unknown, we recommend the use of forensic DNA analysis to address these knowledge gaps to focus conservation and enforcement efforts. Research should continue in the United States to adequately capture the global supply, demand, and trade of tiger parts.

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Cristescu, B., Elbroch, L. M., Dellinger, J. A., Binder, W., Wilmers, C. C., and Wittmer, H. U. (2022). Kill rates and associated ecological factors for an apex predator. Mammalian Biology, 102(2), 291-305. *https://doi.org/10.1007/s42991-022-00240-8*.

ABSTRACT

Kill rates and functional responses are fundamental to the study of predator ecology and the understanding of predatory-prey dynamics. As the most widely distributed apex predator in the western hemisphere, pumas (Puma concolor) have been well studied, yet a synthesis of their kill rates is currently lacking. We reviewed the literature and compiled data on sex- and age-specific kill rate estimates of pumas on ungulates, and conducted analyses aimed at understanding ecological factors explaining the observed spatial variation. Kill rate studies on pumas, while numerous, were primarily conducted in Temperate Conifer Forests (< 10% of puma range), revealing a dearth of knowledge across much of their range, especially from tropical and subtropical habitats. Across studies, kill rates in ungulates/week were highest for adult females with kitten(s) (1.24 ± 0.41 ungulates/week) but did not vary significantly between adult males (0.84 ± 0.18) and solitary adult females (0.99 ± 0.26). Kill rates in kg/day differed only marginally among reproductive classes. Kill rates of adult pumas increased with ungulate density, particularly for males. Ungulate species richness had a weak negative association with adult male kill rates. Neither scavenger richness, puma density, the proportion of non-

ungulate prey in the diet, nor regional human population density had a significant effect on ungulate kill rates, but additional studies and standardization would provide further insights. Our results had a strong temperate-ecosystem bias highlighting the need for further research across the diverse biomes pumas occupy to fully interpret kill rates for the species. Data from more populations would also allow for multivariate analyses providing deeper inference into the ecological and behavioural factors driving kill rates and functional responses of pumas, and apex predators in general.

Harano, T., and Kutsukake, N. (2022). Way to big cats: Directional selection in body size evolution in living felids. Journal of Mammalian Evolution, 30(1), 97-108. *https://doi.org/10.1007/s10914-022-09639-z*.

ABSTRACT

Body size correlates with various biological attributes. Hence, its evolution has attracted considerable attention. The family Felidae (Mammalia: Carnivora) has extensive variation in body size among extant species, with a few species being strikingly larger. The body size of extremely large species compared with phylogenetically related species may have evolved through directional selection toward increased size in a particular lineage, although lineage-specific directional selection has not been explicitly incorporated into standard models of body size evolution on a phylogeny. We used simulation-based likelihood and approximate Bayesian computation to examine the effect of lineage-specific directional selection on body mass evolution in extant felids. Our analyses revealed the occurrence of lineage-specific directional selection that favors larger body mass in the genus Panthera (lion, Panthera leo; jaguar, Panthera onca; leopard, Panthera pardus; tiger, Panthera tigris; and snow leopard, Panthera uncia), as well as in the cheetah (Acinonyx jubatus) and puma (Puma concolor). Lineage-specific directional selection was not detected in the clouded leopard (Neofelis nebulosa), which, along with the genus Panthera, diverged early from all other extant felids. The cheetah, puma, and jaguarundi (Puma yagouarondi) compose a monophyletic group in which body size may have decreased during the evolution of the jaguarundi, although our analyses revealed no lineage-specific directional selection for smaller sizes in the species. Directional selection for increased body size shown herein seems to be associated with a lifestyle dependent on relatively large prey. This selection may be accelerated by the features of solitary hunters in felids.

Morphology

Cooper, D. M., Yamaguchi, N., Macdonald, D. W., Nanova, O. G., Yudin, V. G., Dugmore, A. J., and Kitchener, A. C. (2022). Phenotypic plasticity determines differences between the skulls of

tigers from mainland Asia. Royal Society Open Science, 9(11), 220697. https://doi.org/10.1098/rsos.220697.

ABSTRACT

Tiger subspecific taxonomy is controversial because of morphological and genetic variation found between now fragmented populations, yet the extent to which phenotypic plasticity or genetic variation affects phenotypes of putative tiger subspecies has not been explicitly addressed. In order to assess the role of phenotypic plasticity in determining skull variation, we compared skull morphology among continental tigers from zoos and the wild. In turn, we examine continental tiger skulls from across their wild range, to evaluate how the different environmental conditions experienced by individuals in the wild can influence morphological variation. Fifty-seven measurements from 172 specimens were used to analyse size and shape differences among wild and captive continental tiger skulls. Captive specimens have broader skulls, and shorter rostral depths and mandible heights than wild specimens. In addition, sagittal crest size is larger in wild Amur tigers compared with those from captivity, and it is larger in wild Amur tigers compared with other wild continental tigers. The degree of phenotypic plasticity shown by the sagittal crest, skull width and rostral height suggests that the distinctive shape of Amur tiger skulls compared with that of other continental tigers is mostly a phenotypically plastic response to differences in their environments.

MONITORING AND ASSESSMENT

Efford, M. G., and Schofield, M. R. (2022). A review of movement models in open population capture–recapture. Methods in Ecology and Evolution, 13(10), 2106-2118. https://doi.org/10.1111/2041-210x.13947.

ABSTRACT

Understanding rates of survival and recruitment is critical to population man-agement, and capture–recapture methods of estimation are widely used. Spatial models allow for a spatial detection process and can include the movement of activity centres between sampling times. Movement is often treated as a ran-dom walk with the step length governed by a probability kernel. However, the movement component of open population spatially explicit capture–recapture models (open SECR) has evolved haphazardly and comparison among studies is difficult.2. We review published studies, document suitable probability kernels and address the issues of scale and buffer dependence in open SECR by a combination of simulation and case studies on ovenbirds Seiurus aurocapilla and tigers Panthera tigris.3. Flexible 2- parameter kernels, such as the bivariate t- distribution, fit better than the popular bivariate normal and

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resulted in higher estimates of survival. We reconcile different parameterizations of the bivariate t- distribution and identify a problem when the kernel is defined in terms of its margins.4. Movement models failed to separate mortality and emigration in simulated data when the data were a random mixture of long and short movements. Our es-timates of ovenbird survival were buffer-dependent, and we interpret this as a sign that the data are inadequate for joint modelling of survival and movement. Estimates of tiger survival were more nearly asymptotic on buffer width.5. We repeat the warning of earlier authors that movement models are effective for separating mortality and emigration only when the data span the range of movement. We appeal for more complete and consistent reporting of move-ment models and identify topics for future research.

GENETICS

Armstrong, E. E., Campana, M. G., Solari, K. A., Morgan, S. R., Ryder, O. A., Naude, V. N., Samelius, G., Sharma, K., Hadly, E. A., and Petrov, D. A. (2022). Genome report: chromosome-level draft assemblies of the snow leopard, African leopard, and tiger (Panthera uncia, Panthera pardus pardus, and Panthera tigris). G3 (Bethesda, Md.), 12(12), jkac277. https://doi.org/10.1093/g3journal/jkac277.

The big cats (genus Panthera) represent some of the most popular and charismatic species on the planet. Although some reference genomes are available for this clade, few are at the chromosome level, inhibiting high-resolution genomic studies. We assembled genomes from 3 members of the genus, the tiger (Panthera tigris), the snow leopard (Panthera uncia), and the African leopard (Panthera pardus pardus), at chromosome or near-chromosome level. We used a combination of short- and long-read technologies, as well as proximity ligation data from Hi-C technology, to achieve high continuity and contiguity for each individual. We hope that these genomes will aid in further evolutionary and conservation research of this iconic group of mammals.

Ibrahim, S., Talha, N. A. H., Kim, J., Jeon, Y., and Yu, I. (2022). Cryopreservation of Siberian tiger (Panthera tigris altaica) epididymal spermatozoa: pilot study of post-thaw sperm characteristics. Journal of Animal Reproduction and Biotechnology, 37(2), 130-135. *https://doi.org/10.12750/jarb.37.2.130*.

Epididymal sperm cryopreservation provides a potential method for preserving genetic material from males of endangered species. This pilot study was conducted to develop a freezing method for tiger epididymal sperm. We evaluated post-thaw sperm condition using testes with intact epididymides obtained from a Siberian tiger (Panthera tigris altaica) after castration. The epididymis was chopped in Tyrode's albumin-lactate-pyruvate 1x and incubated at 5% CO2, 95% air for 10 min. The Percoll separation density gradient method was used for selective recovery of motile spermatozoa after sperm collection using a cell strainer. The spermatozoa were diluted with modified Norwegian extender supplemented with 20 mM trehalose (extender 1) and subsequent extender 2 (extender 1 with 10% glycerol) and frozen using LN2 vapor. After thawing at 37°C for 25 s, Isolate® solution was used for more effective recovery of live sperm. Sperm motility (computerized assisted sperm analysis, CASA), viability (SYBR-14 and Propidium Iodide) and acrosome integrity (Pisum sativum agglutinin with FITC) were evaluated. The motility of tiger epididymal spermatozoa was 40.1 ± 2.0%, and progressively motile sperm comprised 32.7 ± 2.3%. Viability was 56.3 ± 1.6% and acrosome integrity was 62.3 ± 4.4%. Cryopreservation of tiger epididymal sperm using a modified Norwegian extender and density gradient method could be effective to obtain functional spermatozoa for future assisted reproductive practices in endangered species. Keywords: CASA, cryopreservation, epididymal sperm, Siberian tiger.

SUSTAINABLE SOLUTIONS AND TECHNOLOGY

Schneider, S., Taylor, G. W., and Kremer, S. C. (2022). Similarity learning networks for animal individual re-identification: an ecological perspective. Mammalian Biology, 102(3), 899-914. *https://doi.org/10.1007/s42991-021-00215-1*.

ABSTRACT

The ability for researchers to re-identify animal individuals upon re-encounter is fundamental for the study of population dynamics, community, and behavioural ecology. Animal re-identification is traditionally performed using tagging or DNA sampling, which is laborious, invasive to an animal, and expensive. An alternative approach to re-identify is the use of computer vision in combination with pattern recognition algorithms. Deep learning has accelerated the success when solving pattern recognition in the field of computer vision when high data volume is available; however, conventional deep learning approaches require ample training data for a fixed number of classes. An alternative deep learning paradigm is similarity comparison networks which are trained to identify if two inputs are the same or different. This principle can be applied to images of animal individuals and allows for the re-identification of individuals beyond the original training data. Here, we test the potential and generality of similarity comparison networks for animal re-identification considering five datasets of different species: humans, chimpanzees, humpback whales, fruit flies, and Siberian tigers, each with their own unique set of challenges. We compare 10 similarity comparison networks by testing five well-established network architectures (AlexNet, VGG19, DenseNet201, ResNet152, and InceptionV3) and two different methods to train each of them: contrastive and triplet loss. Models were trained to re-identify individuals and those trained using the triplet loss outperformed contrastive loss for all species. Our work shows that without any species-specific modifications, similarity comparison networks can act as a general purpose animal re-identification system considering individuals from images. Our expectation is that similarity comparison networks are the beginning of a major trend that has the potential to revolutionize the study of population dynamics, community, and behavioural ecology. This work is an extension of a technical report presented at WACV 2020 (IEEE/CVF winter conference on applications of computer vision workshops) catered for an ecological audience.

ZOOLOGY AND ANIMAL WELFARE

Alonso, B., Bouts, T., Gasthuys, F., and Schauvliege, S. (2022). Anesthesie van vijf amurtijgers (Panthera tigris altaica) met een combinatie van medetomidine en ketamine. Vlaams Diergeneeskundig Tijdschrift, 91(5). *http://dx.doi.org/10.21825/vdt.85301*.

ABSTRACT

Five adult healthy captive male amur tigers were anesthetized using a combination of medetomidine (0.03 mg/kg) and ketamine (2.5 mg/kg) target doses. After darting, the mean time to de-cubitus was 5 ± 1 minutes and to approach 13 ± 2.4 minutes. The time between approaching andthe end of the procedure was 16.2 ± 3.3 minutes, and between darting and administering

the an-tagonist 32.8 ± 4 minutes. After administration of atipamezole (0.08 mg/kg IV), the mean time toregain sternal recumbency was 9.4 ± 4.6 minutes and to stand 23 ± 11.4 minutes. Medetomidinein association with ketamine in single-dart injection produced fast and safe chemical restraintin the healthy tigers. Partial reversal with 15 mg of atipamezole IV resulted in a short recoveryduration without obvious side effects.

Shibu Nair

Andrews, B. J., Cushing, A. C., Murphy, R. E., Wilson, E. M., and Sula, M. M. (2022). Blood concentration of symmetric dimethylarginine correlates with kidney damage as assessed with a proposed histologic grading system for chronic kidney disease in tigers (Panthera tigris). Journal of the American Veterinary Medical Association, 260(13), 1-8. *http://dx.doi.org/10.2460/javma.21.04.0216*

ABSTRACT

Objective: To determine the utility of blood symmetric dimethylarginine (SDMA) concentration measurement as a diagnostic tool for chronic kidney disease (CKD) in tigers (Panthera tigris) by comparing results for SDMA with those for traditional renal biomarkers and investigating correlations between these biomarkers and histopathologic kidney changes in tigers with CKD. Sample: Blood, urine, and kidney samples from 35 tigers with CKD from 2 sanctuaries. Procedures: Blood (serum or plasma) and urine samples were collected antemortem. Necropsy, including

gross and histologic assessment, was performed for tigers that died or were euthanized for quality-of-life reasons. Results for CKD biomarkers in blood (BUN, creatinine, phosphorus, and SDMA concentrations) and urine (protein concentration, urine protein-to-creatinine ratio, and urine specific gravity) were evaluated for correlation with histologic kidney damage scored with an objective grading scale defined by percentage of inflammation, fibrosis, and tubular atrophy. Results: Symmetric dimethylarginine had the strongest significant correlation (ρ = 0.667) with histologic kidney damage score, followed by urine specific gravity (ρ = -0.639), blood creatinine concentration (ρ = 0.624), and BUN (ρ = 0.588). No significant correlation with kidney score was identified for blood phosphorus concentration, urine protein concentration, or the urine protein-to-creatinine ratio. Clinical relevance: We recommend SDMA be prioritized as a renal biomarker in tigers, with SDMA results considered in addition to those of other traditional renal biomarkers when assessing kidney function in tigers. Additionally, the grading scale we developed could be replicated across patients and pathologists for more consistent postmortem assessment of CKD in tigers.

Carlson, A. K., Ramsay, E. C., Sun, X., Chaffins, D., and Sula, M. J. (2022). Endometrial hyperplasia and pyometra in captive lions (Panthera leo) and tigers (Panthera tigris). Veterinary Pathology, 59(6), 1003-1011. *http://dx.doi.org/10.1177/03009858221109094*.

ABSTRACT

Endometrial hyperplasia (EH) is a pathologic condition of the uterus with increased endometrial gland to stroma ratio compared to normal cyclic uterine proliferation. In domestic animals, EH often involves cystic distension of proliferating endometrial glands and may be concurrent with pyometra. In large captive nondomestic felids, an association between EH and pyometra is common; however, detailed species differences between the histological uterine findings in lions (Panthera leo) and tigers (Panthera tigris) and clinical manifestations have yet to be described. Uterine sections from 14 lions and 24 tigers with EH and/or pyometra were scored for several histological parameters and clinical histories were recorded. The percentage of endometrium affected by hyperplasia, endometrial gland to stroma ratio, and adenomyosis were significantly (P = .0385, P = .0008, and P = .0463, respectively) more severe in lions compared to tigers as univariate analytes. Although tubular complexity was not statistically significant (P = .3254), when combined as a proposed EH grading scheme, these 4 features confirmed lions had significantly (P = .0068) more severe EH compared to tigers. Endometrial hyperplasia severity significantly correlated with inflammation/pyometra severity when controlling for species (P = .0203). A significant correlation exists between pyometra-associated clinical sign severity and the presence of pyometra in tigers, (P = .0026) but not in lions (P = .1144). There was no statistical difference in the severity of clinical signs associated with pyometra between these species (P = .1986). This proposed grading scheme may have clinical utility in providing

a more consistent and objective evaluation of EH in large captive felids.

Cerreta, A. J., Yang, T. S., Ramsay, E. C., Birkenheuer, A. J., Rahoi, D., Qurollo, B., Wilson, J., and Cushing, A. C. (2022). Detection of vector-borne infections in lions and tigers at two zoos in Tennessee and Oklahoma, USA. Journal of Zoo and Wildlife Medicine, 53(1), 50-59. *http://dx.doi.org/10.1638/2020-0199*.

ABSTRACT

Protozoal and bacterial vector-borne infections are frequently diagnosed in domestic felids. However, with the exception of Mycoplasma haemofelis and Cytauxzoon felis, their occurrence in managed nondomestic felids housed in the United States is largely unknown. Following a case in February 2020 of fulminant cytauxzoonosis in an African lion (Panthera leo), EDTA-whole blood samples were collected opportunistically from February 2020 through June 2020 from 34 adult tigers (Panthera tigris) and eight adult African lions from the same sanctuary in eastern Tennessee as well as 14 adult tigers from a zoo in southern Oklahoma. Samples were analyzed for Cytauxzoon felis, Bartonella spp., hemotropic Mycoplasma, Rickettsia spp., Anaplasma spp., Ehrlichia spp., Babesia spp., and Hepatozoon spp. DNA by PCR amplification. All animals were asymptomatic at the time of collection. None of the Oklahoma animals were positive for vector-borne organisms, but these pathogens were detected in tigers at the Tennessee facility, including Cytauxzoon felis (11.8%), "Candidatus Mycoplasma haemominutum" (5.9%), and Ehrlichia ewingii (2.9%). During the study period, two animals developed clinical signs of cytauxzoonosis and were assessed for vector-borne infections as part of their diagnostic evaluation. This study documents the presence of tick-borne diseases in managed nondomestic felids in the southeastern United States and underscores that ectoparasite control measures should be practiced to minimize exposure of carnivores in managed care.

Cushing, A. C., Murphy, R., Szlosek, D., Gauger, V., Coyne, M. J., and Obare, E. (2022). Method comparison for measurement of symmetric dimethylarginine in tigers (Panthera tigris). Journal of Zoo and Wildlife Medicine: Official Publication of the American Association of Zoo Veterinarians, 53(1), 200-. *http://dx.doi.org/10.1638/2021-0067*.

ABSTRCAT

Renal disease is well documented in nondomestic felids and is monitored and diagnosed by serum concentration of blood urea nitrogen, creatinine, and phosphorous. Symmetric dimethylarginine (SDMA) has proven to be an earlier and more sensitive biomarker for the assessment of glomerular filtration rate. Although SDMA is commonly measured in nondomestic felids, information concerning the validity of the assay is lacking. The purpose

of the study was to perform a method comparison between high-throughput immunoassay and the reference method, liquid chromatography-tandem mass spectrometry (LC-MS/MS), to quantify SDMA concentrations in tiger blood samples. Concentrations of SDMA were measured for 81 individual tiger samples. The SDMA immunoassay demonstrated excellent correlation to the LC-MS/MS reference method. A Passing and Bablok linear regression analysis had a slope of 1.03 (95% CI, 0.99-1.11), an intercept of 1.64 (95% CI, 0.46-2.34), and a Pearson R= 0.99. The mean bias was 1.53 µg/dl (95% CI, 0.63-2.42 µg/dl), and the limit of agreement was ±7.96 µg/dl. The degree of bias is within established acceptance criteria of 1-3 µg/dl for the immunoassay. Although this study provides good evidence of the utility of the immunoassay to measure SDMA in tiger serum and plasma, further assay validation is recommended.

d'Aquino, I., Piegari, G., Casciaro, S. M., Prisco, F., Rosato, G., Silvestre, P., Uberti, B. D., Capasso, M., Laricchiuta, P., Paciello, O., and Russo, V. (2022). An overview of neoplasia in captive wild felids in southern Italy zoos. Frontiers in Veterinary Science, 9, 899481-. *http://dx.doi.org/10.3389/fvets.2022.899481*.

ABSTRACT

The aim of this study was to evaluate the frequency of neoplasms in captive wild felids in Southern Italy zoos over a 13-year period (2008–2021) and to investigate macroscopic and histologic tumor findings in these animals. A total of 24 cases were necropsied, 9 males and 15 females, with age ranging from 6 to 19 years, including 12 tigers (Panthera tigris), 7 leopards (Panthera pardus), 4 lions (Panthera leo), and 1 black jaguar (Panthera onca). Diagnosis of neoplasm was made in 14/24 cases (58.3%). Tumors diagnosed were two cholangiocarcinomas, two hemangiosarcomas of the liver, two uterine leiomyomas, a renal adenocarcinoma, an adrenal gland adenoma, a thyroid carcinoma, an oral squamous cell carcinoma, an osteoma, a meningioma, a mesothelioma, an esophageal leiomyosarcoma, a muscoloskeletal leiomyosarcoma and a thyroid adenoma. The malignant and benign tumors were 62.5 and 37.5%, respectively. Among malignant tumors, no metastasis was observed in 50% of cases; in 10% of cases metastasis involved only regional lymph nodes; and distant metastases were found in 40% of cases. Based on our findings, the liver was the most frequent primary tumor site (25%). The high rates of malignant and widely metastatic neoplasms suggest the importance of active monitoring and management of neoplasia in these threatened and endangered species.

Fugazzotto, D., Costa Devoti, C., Cassano, I., Berti, E., Brusati, M., and Zeira, O. (2022). Clinical and diagnostic imaging findings in a Bengal tiger (Panthera tigris tigris) with cervical spondylomyelopathy: A case report. Brazilian Journal of Veterinary Medicine, 44, e003921. DOI: 10.29374/2527-2179.bjvm003921.

ABSTRACT

An adult neutered male Bengal tiger (Panthera tigris tigris) presented with abnormal gait. Neurological examination showed poor left ambulatory hemiparesis, spontaneous proprioceptive deficit in the left anterior limb, and decreased flexor reflex in the forelimbs. The neurological symptoms suggested a caudal cervical spinal cord lesion. Pathological findings included increased cholinesterase and protein levels in the cerebrospinal fluid. Computed tomography examination revealed C2-C3 intervertebral disc herniation, C5-C6 intervertebral disc herniation associated with a reduction of the intervertebral space, and mild ventral dislocation of the C6 vertebra compared to C5. In addition, severe bilateral shoulder osteoarthritis and a hypoattenuating nodule in the left thyroid gland with an open etiology were observed. These findings were interpreted as indicating cervical spondylomyelopathy (CSM). Treatment included analgesic and steroidal anti-inflammatory therapy as well as movement restriction. Follow-up at 4 weeks showed modest improvement. Thus, CSM should be included in the differential diagnosis of tigers with neurological cervical signs.

Iaria, C., Ieni, A., Cicero, L., Briguglio, G., Di Maria, S., and Abbate, J. M. (2022). Primary ovarian leiomyoma in a white tiger (Panthera tigris). Veterinary Sciences, 9(12), 702-702. *http://dx.doi.org/10.3390/vetsci9120702*.

ABSTRACT

Ovarian leiomyomas are very rare in domestic cats and occasionally mentioned in studies reporting general pathological findings and neoplasm occurrence in non-domestic large felids. This report describes a case of ovarian leiomyoma in a 22-year-old white tiger (Panthera tiger), treated with deslorelin implants, detailing pathological and immunohistochemical characteristics. Gross examination revealed a markedly enlarged, firm, whitish right ovary with a multinodular appearance. On a cut surface, multiple brown-fluid-filled cysts interspersed with solid grey-to-white areas were observed. On histopathological examination, the ovary was enlarged and replaced by a densely cellular neoplasm composed of spindle cells arranged in fascicles, or occasionally in a herringbone pattern, embedded in a large stroma of collagenous connective tissue. Neoplastic cells showed mild nuclear atypia and pleomorphism and low mitotic rate. Immunohistochemistry confirmed smooth muscle origin of the neoplasm, and cells were positive for vimentin, alpha-smooth muscle actin, desmin, and caldesmon. A low rate (<1%) of Ki-67-positive cells was observed. Although rare, ovarian leiomyoma should be considered when a mass is present in the ovary of a tiger with reproductive failure. Because cancer of the reproductive system impacts on species conservation by affecting reproduction, regular health monitoring is warranted to support wildlife conservation. Finally, the adverse effects associated with long-term treatment with synthetic GnRH analogues as contraceptives in non-domestic felids are worthy of future investigation.

Kane, L. P., Cook, J. L., Archibald, K. E., Suedmeyer, W. K., Langan, J. N., and Adkesson, M. J. (2022). Complications associated with total hip arthroplasty in four large nondomestic felids. American journal of veterinary research, 83(2), 180–187. *https://doi.org/10.2460/ajvr.21.10.0161*.

ABSTRACT

Case description: A 9-year-old 37-kg sexually intact male snow leopard (Panthera uncia) with no history of lameness but radiographic evidence of right femoral subluxation and flattening of both femoral heads, 2 juvenile (< 1 year old) 25-kg sexually intact male cheetahs (Acinoynx jubatus) with unilateral hind limb lameness resulting from trauma, and an 11-year-old 110-kg sexually intact female Amur tiger (Panthera tigris altaica) with a 2-year history of left hip joint osteoarthritis were examined.

Clinical findings: No clinically relevant clinical findings other than hip joint problems were identified. All 4 felids underwent staged bilateral (snow leopard) or unilateral (cheetahs and tiger [Panthera tigris]) total hip arthroplasty (THA).

Treatment and outcome: In the snow leopard, both femoral THA components were found to be luxated 1 year after surgery. Treatment consisted of autogenous corticocancellous rib graft augmentation of the dorsal acetabular rims and synthetic suture capsulorrhaphies. The snow leopard lived for an additional 4 years with no additional THA-related complications. In the other 3 animals, catastrophic complications (luxation in the cheetahs and femoral fracture in the tiger) occurred shortly after THA. The THA implants were removed, and excision arthroplasty was performed. Long-term outcomes were good in all 3.

Clinical relevance: Findings underscore the challenges associated with THA in large nondomestic felids. Given the high risk for early catastrophic failure as a result of luxation or fracture, plans must be made and resources must be available in case revision surgery or implant removal with excision arthroplasty becomes necessary.

Kukhar, Y., Smagulova, A., and Kiyan, V. (2022). Generalized Dermatophytosis of Combined Etiology in a Circus Tiger (Panthera Tigris Altaica). International Journal of Veterinary Science, 11(4), 552-556.

ABSTRACT

There have been few reports on the generalized tinea caused by mixed infection and its treatment. The article describes a case of combined tiger dermatophytosis caused by Microsporum canis and opportunistic skin mycosis associated with mixed aspergillosis infection. The infected hair was affected by fungal elements, confirmed by Wood's lamp and cultural and morphological studies. Cultural and morphological diagnostics were carried out by inoculation of biomaterial on differential Sabouraud media with cycloheximide. The causative agent of classic dermatomycosis Microsporum canis and the causative agents of opportunistic mycoses fungi of the genus Aspergillus were isolated and identified from the affected foci on the skin of a tiger cub. Dermatosis of combined etiology was diagnosed. The preparations were selected and treated for the generalized mycosis of the tiger cub. Itraconazole was effective for treatment. There have been few reports on the generalized tinea caused by mixed infection and its treatment. The article describes a case of combined tiger dermatophytosis caused by Microsporum canis and opportunistic skin mycosis associated with mixed aspergillosis infection. The infected hair was affected by fungal elements, confirmed by Wood's lamp and cultural and morphological studies. Cultural and morphological diagnostics were carried out by inoculation of biomaterial on differential Sabouraud media with cycloheximide. The causative agent of classic dermatomycosis Microsporum canis and the causative agents of opportunistic mycoses fungi of the genus Aspergillus were isolated and identified from the affected foci on the skin of a tiger cub. Dermatosis of combined etiology was diagnosed. The preparations were selected and treated for the generalized mycosis of the tiger cub. Itraconazole was effective for treatment.

Kopp, E., Stelzer, P., Lendl, C., Meyer-Lindenberg, A., and Fahrenkrug, P. (2022). A standard method for intraoral dental radiography with dental photo-stimulative phosphor (PSP) plates in big cats. Journal of Veterinary Dentistry, 39(4), 337-345. *http://dx.doi.org/10.1177/08987564221126373*.

ABSTRACT

In recent years, dentistry has steadily gained more prominence in veterinary medicine, including exotic and wild animal medicine. It is known that dental diseases are among the most common diseases in captured big cats. However, so far, there is no standardized method for dental radiography in these animals. Therefore, this study aimed to develop a standardized procedure

for the systematic radiographic examination of the teeth in big cats. In total, 34 big cats, including 21 lions and 13 tigers, of different ages were examined. Animals that needed treatment for known dental diseases and those that had to be anesthetized for other medically necessary procedures and dental health status examinations were included. Intraoral dental radiographs were captured with digital imaging plates designed for intraoral dental radiography in horses. Based on the intraoral dental radiography procedures used in domestic cats, both the bisecting angle technique and parallel technique were used. A hemisphere model originally developed for horses was used to describe the path and position of the x-ray beam as accurately as possible. The results demonstrated that it was possible to completely image all the teeth of big cat dentition on seven radiographs using the described method. This method can be used to acquire high-quality intraoral dental radiographs in big cats, aiding in the quick and reliable diagnosis of dental diseases.

Maniscalco, L., Acutis, P. L., Biolatti, C., Laguardia, D. R., Di Blasio, A., Dondo, A., Bozzetta, E., and Varello, K. (2022). Renal carcinoma with metastatic spread in a tiger (Panthera tigris): Morphological and immunohistochemical study. Veterinaria Italiana, 58(4), -. *http://dx.doi.org/10.12834/vetit.2475.16553.2*.

ABSTRACT

A 12-year-old intact male Panthera tigris presented with pain and weight loss was euthanatized. Necroscopical examination revealed a neoplastic mass expanding to the left renal pelvis with metastatic dissemination to local lymph node, adrenal gland, and lung. Immunohistochemical characterization was performed revealing co-expression of both cytokeratin and vimentin and negativity for both PAX8 and c-KIT. Considering histochemical and immunohistochemical results the tumour was classified as renal cell carcinoma with metastatic spread. This report provides insights into the morphological and immunohistochemical features of renal cell carcinoma in Panthera tigris.

Mazzotta, E., Foiani, G., De Benedictis, G. M., Fiore, E., Natale, A., Spagnolo, E., Vascellari, M., Cento, G., and Corrò, M. (2022). Salmonella Enteritidis fatal septicemia with meningoencephalitis in a tiger (Panthera tigris) cub. Animals, 12(19), 2490-2490. *http://dx.doi.org/10.3390/ani12192490*.

ABSTRACT

A 15-day-old, female, captive Panthera tigris cub was hospitalized after developing severe hyperthermia, depression, and lack of appetite. The clinical condition rapidly worsened, and the tiger cub died in 72 h after the onset of neurological symptoms, septic shock, and multiple

organ dysfunction syndrome. The postmortem main gross findings consisted of a severe and diffuse bilateral fibrino-suppurative meningoencephalitis and ventriculitis, mild fibrinous and sero-hemorrhagic polyserositis and cystitis, severe pulmonary edema, and hemorrhages. Microscopically, the meninges, ependyma, and choroid plexuses were diffusely expanded by abundant infiltration of neutrophils and macrophages, with multifocal fibrinous exudation. Histiocytic interstitial pneumonia, fibrinous and neutrophilic polyserositis, and pyelocystitis were also observed. Vascular thrombosis with multifocal vasculitis and vascular necrosis were frequently observed. Aerobic and anaerobic cultures performed on the brain, lungs, intestine, kidneys, and in pericardial effusion reported the presence of Salmonella enterica subsp. enterica serovar Enteritidis. Environmental and nutritional contamination were identified as putative sources of infections. To the best of the authors' knowledge, this is the first report of Salmonella Enteritidis septicemia with meningoencephalitis in a tiger cub, which highlights the need to further investigate the cause of acute perinatal death to reduce the risk of infectious disease outbreaks.

Mukhtar, M. U., Iqbal, N., Yang, J., Nawaz, Z., and Peng, T. L. (2022). The first molecular identification and phylogenetic analysis of tick-borne pathogens in captive wild animals from Lohi Bher zoo, Pakistan. Parasitology Research, 121(11), 3321-3326. *http://dx.doi.org/10.1007/s00436-022-07666-6*.

ABSTRACT

Tick-borne pathogens are causing severe diseases in livestock, wild animals, and humans. Wild animals play a crucial role in tick-borne pathogens' transmission life cycle by serving as reservoir hosts or intermediate hosts, posing a continuous risk for domestic animals and humans. The presence of tick-borne pathogens is often ignored in wild animals kept in zoos, which is a public health concern. In the present study, we investigated these pathogens in tick-infested captive wild animals at the Lohi Bher zoo, Pakistan. Blood samples were collected from 22 animals, which include urials (4) (Ovis aries vignei), blackbucks (3) (Antilope cervicapra), fallow deer (1) (Dama dama), hog deer (6) (Axis porcinus), chinkaras (4) (Gazella bennettii), white tiger (2) (Panthera tigris tigris), a giraffe (Giraffa camelopardalis), and African lions (2) (Panthera leo). The samples were screened for Piroplasm and Anaplasma spp. by polymerase chain reaction targeting different gene loci. We detected three Theileria spp. and one Anaplasma sp. from the investigated captive wild animals. The Theileria sp. dama gazelle was detected from chinkara, Theileria sp. NG-2012b from chinkara and giraffe and T. parva from African lion, and Anaplasma bovis was identified in a giraffe. Moreover, Theileria sp. and Anaplasma sp. coinfection was detected in one giraffe. Overall, this study shows that Theileria spp. and Anaplasma spp. are circulating in captive wild animals, which can play an important role in their spread. Further studies are required to monitor tick-borne pathogens in zoo animals and their potential to spread from exotic wild captive animals to local wild and domestic.

Nagy, A., Stará, M., Vodička, R., Černíková, L., Jiřincová, H., Křivda, V., and Sedlák, K. (2022). Reverse-zoonotic transmission of SARS-CoV-2 lineage alpha (B.1.1.7) to great apes and exotic felids in a zoo in the Czech Republic. Archives of Virology, 167(8), 1681-1685. *http://dx.doi.org/10.1007/s00705-022-05469-9*.

ABSTRACT

We report an outbreak of SARS-CoV-2 lineage alpha in gorillas and felid species in a zoo in Prague, Czech Republic. The course of illness and clinical signs are described, as are the results of characterization of these particular SARS-CoV-2 variants by next-generation sequencing and phylogenetic analysis. The putative transmission routes are also discussed.

Orlandi, M., Giglia, G., Danesi, P., Laricchiuta, P., and Abramo, F. (2022). Eumycetoma caused by Madurella pseudomycetomatis in a captive tiger (Panthera tigris). Journal of Fungi (Basel, Switzerland), 8(12), 1289-1289. *http://dx.doi.org/10.3390/jof8121289*

ABSTRACT

A captive-kept adult male tiger presented with a large cutaneous and subcutaneous mass on the thigh with a fistula. During sedation, multiple nodules were detected and samples for a histopathological exam were collected. Histologically, granulomatous panniculitis and dermatitis were seen around dense aggregates of pigmented fungal hyphae, and a diagnosis of phaeohyphomycosis was made; considering the clinical features, it was classified as a eumycotic mycetoma. This is a rarely reported subcutaneous fungal infection in humans and animals, caused by dematiaceous fungi. Clinically, it is characterized by tumefaction, fistulous sinus tracts, and the formation of macroscopically visible grains. In the literature, only a few infections in wild felids have been reported. In this case, Fontana–Masson staining better showed pigmentation and panfungal PCR and sequencing identified Madurella pseudomyectomatis (OP623507) as the causative agent. Systemic therapy with oral administration of itraconazole was planned, but the patient died during the first period of treatment. The animal was not submitted for post-mortem examination. Visceral dissemination of the agent cannot be excluded. To the authors' knowledge, this is the first report of eumycotic mycetoma by Madurella pseudomycetomatis in a captive tiger.

Rangel, M., and Da Silva Júnior, N. (2022). Environmental food and cognitive enrichment: A study of well-being for large captive felids at the Zoo of Goiânia. Journal of Veterinary Health Science, 3(2). *http://dx.doi.org/10.33140/jvhs.03.02.07*.

ABSTRACT

In order to promote research and conservation of species, zoos tend to promote the modernization of this system, such as the insertion of larger and adequate enclosures, environmental enrichments, and above all the conservation of species. The main objectives of this work were: to promote environmental food and cognitive enrichment for big cats, in addition to discussing the validity of this enrichment model. The study animals were 12 animals: four tigers (Panthera tigris), three puma (Puma concolor), three jaguars (Panthera onca) and two lions (Panthera leo). We used a basic ethogram for the analysis of behaviors, in which there was an analysis of specific behavior: rhythm and inactivity. With the focal animal observation method, and using the "surprise box" enrichment method, which consisted of pieces of meat inside cardboard boxes, the statistical results obtained indicated that enrichment increased social, rest and physiological behavior, and slowed down and downtime. Each species reacted in a specific way to enrichments, with better results being noticed with the Panthera onca group, followed by the Panthera leo, Panthera tigris and Puma concolor group, respectively. The theory of the use of environmental enrichment was proven and compared with other works similar to this one.

Smith, K. D., Snider, R. J., Dembiec, D. P., Siegford, J. M., and Ali, A. B. (2022). Effects of a modern exhibit design on captive tiger welfare. Zoo Biology, 42(3), 371-382. *http://dx.doi.org/10.100*

ABSTRACT

Offering captive animals larger, more complex spaces are thought to benefit their welfare. To this end, some zoos use trail systems linked to several enclosures. Since little is known about the effects of such designs on the welfare of captive carnivores specifically, we timed the behaviors exhibited by four tigers (Panthera tigris [Linnaeus]) given access to three exhibit configurations: one exhibit only (E, baseline); one exhibit and approximately 19 m2 of trail (ET); and two exhibits connected by approximately 46 m2 of trail (E2T). Behaviors were recorded during 1-h AM, Noon, and PM periods in Phase I (2017), and 2-h AM and PM periods in Phase II (2018). Percentages of behavior occurrence were analyzed using generalized linear mixed models (GLMM), with treatment and time of day as fixed effects. Tigers were least active at noon (Phase I), while active behaviors were prevalent during mornings and afternoons in both Phases. In Phase II (E2T vs. E), active and exploratory behaviors such as sniffing increased, while pacing and inactivity decreased (all $p \leq .001$). We also examined nocturnal tiger movement using infrared motion-activated cameras. In parallel with diurnal observations, tiger activity in E2T greatly exceeded that in E. Nocturnal movement was most pronounced from 1800 to 2200 and least frequent from 0100 to 0400, closely matching patterns observed in the wild. Results

indicate that offering tigers voluntary access to larger and more complex spaces stimulates natural behaviors and decreases stereotypical behaviors.

van der Weyden, L., Caldwell, P., Steyrer, C., O'Dell, N., and Henning, A. (2022). Sinonasal meningioma in a Siberian tiger (Panthera tigris altaica). Veterinary Sciences, 9(9), 457-457. *http://dx.doi.org/10.3390/vetsci9090457*.

ABSTRACT

Meningiomas are the most common primary brain tumour in dogs and cats. However, whilst there are numerous reports of extracranial (spinal, orbital and sinonasal) meningiomas in the dog, there have only been a few case reports of spinal meningiomas, and no post-mortem confirmed orbital or sinonasal meningiomas in cats. In this report, a 20-year-old captive tiger (Panthera tigris altaica) with a history of chronic ocular inflammation resulting in enucleation, spontaneously developed tetanic convulsions (epileptic seizures) that over a 2-year period resulted in a gradually worsening condition and the animal was eventually euthanized. At autopsy, a focal, expansile, neoplastic mass was found in the caudal nasal cavity midline, abutting the cribriform plate and slightly compressing the calvarium. Histological analysis revealed nasal turbinates attached to a well-circumscribed expansile multi-lobular mass consisting of interlacing whorls and streams of neoplastic cells supported by a variably fibrous to microcystic collagenous matrix displaying rare psammoma bodies. The diagnosis was sinonasal transitional meningioma. This is the first report of a captive wild felid with an extracranial meningioma, specifically a tiger with a sinonasal transitional meningioma.

van der Weyden, L., Tibbs, C., Knott, C., and Dobromylskyj, M. (2022). Metastatic urothelial carcinoma of the urinary bladder in a Sumatran tiger (Panthera tigris sondaica). Veterinary Medicine and Science, 8(3), 1288–1293. *https://doi.org/10.1002/vms3.771*

ABSTRACT

A 15-year-old spayed female Sumatran tiger (Panthera tigris sondaica) was presented with a short history of haematuria and dysuria, non-responsive to antibiotics, and a gradual decline to inappetence over a period of 2-3 months. Ultrasound examination showed a thickened urinary bladder wall and the renal pelvis of right kidney was dilated and cystic. A presumptive diagnosis of renal failure was made, and the tigress was euthanised due to deteriorating quality of life and pronounced weight loss. Histopathology revealed extensive erosion of the urinary bladder wall and marked congestion of the submucosal vasculature, a potential cause of the haematuria observed clinically. Numerous foci of neoplastic cells were also observed throughout the lung parenchyma as well as within lymphatic vessels of the lung, the liver and the kidney. A diagnosis

of a metastatic non-papillary high-grade urothelial carcinoma (UC) of the urinary bladder was made. Consistent with this diagnosis, immunohistochemistry revealed the neoplastic cells were negative for uroplakin III, as has been reported for a subset of high-grade, infiltrative urinary bladder UCs of canines and humans. This is the first report of a primary tumour of the urinary bladder in a tiger and the first report of UC in a tiger.

Webb, J. K., Keller, K. A., Sander, S. J., Allender, M. C., and Sheldon, J. D. (2022). Clinical disease and treatment of Leptospira kirschneri sv Grippotyphosa in a Sumatran tiger (Panthera tigris sumatrae). Journal of the American Veterinary Medical Association, 260(11), 1-6. *http://dx.doi.org/10.2460/javma.21.04.0185*.

ABSTRACT

Case description: A 12-year-old sexually intact male zoo-managed Sumatran tiger (Panthera tigris sumatrae) was evaluated for a 3-day history of vomiting, hyporexia, and lethargy. Radiographs were supportive of gastrointestinal obstruction, and an exploratory laparotomy was performed. Clinical findings: Diffuse tan foci were present on the liver parenchyma, and the tiger became icteric throughout the procedure. Hepatic histopathology and immunohistochemistry resulted in a diagnosis of leptospirosis. Serum microagglutination testing for Leptospira spp antibody titers were positive for L kirschneri serovar Grippotyphosa, rising from 1:400 to 1:3,200 in 2 days. Treatment and outcome: The tiger was treated with antimicrobials, ursodiol, and mirtazapine, and increased biosecurity measures were instituted. Free-ranging wildlife on grounds were trapped, euthanized, and submitted for necropsy to screen for disease vectors. The tiger's urine was intermittently opportunistically collected from the enclosure and remained PCR assay negative for Leptospira spp until being positive once again on day 595. Although the tiger was without clinical signs at that time, antimicrobial therapy and increased biosecurity protocols were instituted a second time until urinary Leptospira shedding was confirmed to have stopped. By 1,071 days after initial presentation, the tiger remained nonclinical, with no additional urinary shedding episodes. Clinical relevance: While domestic and nondomestic free-ranging felids have been reported as subclinical Leptospira spp carriers, this report indicates the clinical importance of leptospirosis when a tiger presents with generalized gastrointestinal signs and icterus. Due to the zoonotic potential, biosecurity measures are necessary. This patient had a clinically successful outcome with antimicrobial therapy and supportive care.

Wirkner, M., Heyder, K., and Ruf, I. (2022). Comparative morphology and postnatal ontogeny of the bony labyrinth in Pantherinae (Felidae, Carnivora) with special emphasis on the lion. Vertebrate Zoology, 72, 883-905. *http://dx.doi.org/10.3897/vz.72.e82874*.

ABSTRACT

The bony labyrinth (inner ear) of mammals reveals systematic as well as morphofunctional information. However, detailed knowledge of bony labyrinth morphology and ontogeny in Pantherinae, that comprise some of the most iconic mammals, is still pending. Hence, we present the first comparative description of the bony labyrinth in all extant species of Panthera and Neofelis some of which are represented by several postnatal stages; particular focus is set on Panthera leo. Our study is based on µCT scans and virtual 3D reconstructions and accompanied by selected morphometric measurements. Even though quite similar in morphology, both genera as well as their species can be distinguished by several features, e.g., shape and relative size of the semicircular canals and presence or absence of an osseous secondary crus commune. In case of the latter, P. pardus shows some intraspecific variation. We also traced the reduction of the fossa subarcuata during ontogeny in P. leo which conforms with previous studies. Negative allometry of the bony labyrinth in relation to skull basal length can be observed during ontogeny as demonstrated by P. leo as well as between different sized species. Although not correlated with the length of the cochlear canal, the number of cochlear turns is higher in captive non-adult P. leo and P. tigris, but lower in adult captive P. pardus. If these intraspecific differences are related to captivity or represent an ontogenetic pattern, needs to be evaluated in future studies based on larger samples.

Zahrah, M., Ulfa, M., and Saragih, R. P. (2022). Welfare management of Sumatran Tiger (Panthera tigris sumatrae) in Medan Zoo and Siantar Zoo. IOP Conference Series: Earth and Environmental Science, 1115(1), 12008-12008. *http://dx.doi.org/10.1088/1755-1315/1115/1/012008*.

ABSTRACT

Panthera tigris sumatrae is one of endemic species of Sumatera Island included in the endangered species red list by the IUCN. The efforts to preserve the sumatran tiger is with conservation activities both in-situ and ex-situ. One form of ex-situ conservation is to keep animals in the zoos. This study aims to assess the welfare level of Sumatran tigers are in Medan Zoo and Siantar Zoo. Aspects of tiger welfare are measured through 5 variables basedon five animal freedom, namely the free of hunger and thirst, the free of environmental discomfort, the free of pain, wounds and diseases, the free of natural behavior and the free of fear and suffering. Data collection through direct observation of animal management and assessment of minimum animal welfare standards. Interviews with veterinarians and animal keepers about human resources and management activities carried out in supporting animal welfare. The assessment is carried out by the management, namely veterinarians, animal keepers, researchers and visitors to obtain objective results. The implementation of sumatran tiger welfare management in Medan Zoo has an average of 76.9 with the category is good and for Siantar Zoo has an average of 95 with the category is very good. Recommendation that needs to be considered from the results of this study is that Medan Zoo needs to add enrichment in the cages that tigers can behave naturally.

INDIA

HUMAN WILDLIFE INTERACTION AND CONFLICT MITIGATION

Chatterjee, M., Chatterjee, N., Chandel, P., Bhattacharya, T., and Kaul, R. (2022). Predicting negative human-tiger (Panthera tigris) interactions in mosaic landscapes around Dudhwa and Pilibhit tiger reserves in India. Frontiers in Conservation Science, 3, 99195.

ABSTRACT

Negative interactions between humans and large carnivores like tigers (Panthera tigris) and leopards (Panthera pardus) are of concern for the conservation of these carnivores, as well as for the health and wellbeing of people who experience such interactions routinely. Such interactions not only lead to human deaths, injuries and loss of domestic animals, but also can result in retaliatory persecution of carnivores and cause their population declines. The Dudhwa-Pilibhit landscape in the northern Indian state of Uttar Pradesh is popularly regarded to be the second most affected hotspot of human-tiger conflicts in the country. Yet, very little information is published on human-tiger conflicts in this landscape. In this study, we recorded 7.4 ± 5.8 (range: 1-20) negative interactions per year between people and tigers that led directly to human deaths and injuries. Although there appeared to be peaks in negative interactions in more recent years, these were found to be statistically non-significant. The peaks in the numbers of cases in 2009-10 and 2016-17 can be attributed to higher numbers of human casualties cause by individual 'problem' tigers, and not due to an increase in the number of tigers engaging in conflicts. We used binomial generalized linear modelling to model the risk to humans from being attacked by tigers depending on landscape characteristics. This approach demonstrated that the mosaics of forests and human settlements, especially the presence of agriculture, forest patches and waterbodies, were the predominant factors at play. Notably, higher risks were not mediated by the presence of larger cattle population. Proximity of villages to forests or natural vegetation patches was the most significantly contributing factor identified by the model output. This suggested that despite the prevalent perception of attacks on humans occurring in human-dominated areas of this landscape, areas with forests or other natural vegetation entailed higher risks. This was corroborated by field observations, with most attacks occurring within, or close to, forests or dense vegetation. Based on these findings, we recommend that restricting human movements and taking precautionary measures in high-risk areas can significantly reduce negative interactions with tigers in our study area.

Malviya, M., Kalyanasundaram, S., and Krishnamurthy, R. 2022. Paradox of success-mediated conflicts: analysing attitudes of local communities towards successfully reintroduced tigers in India. Frontiers in Conservation Science, 2, p.783467.

ABSTRACT

Conservation programs such as reintroductions are pivotal for the survival and proliferation of endangered species like tigers. However, restoring a carnivore population may create unforeseen problems for communities by fuelling human-wildlife conflict. The long-term persistence of tigers can only be ensured when the support of these local communities is garnered for conservation efforts, especially in release sites from where they were initially eliminated due to anthropogenic causes. The first step to gaining support for tigers and their reintroduction programs is to understand how local communities perceive these large carnivores. This study thus assessed the attitudes of local communities towards the reintroduced tigers of India, in the Panna and Sariska Tiger Reserves, and examined the socio-economic factors that potentially shape their attitudes. Questionnaire surveys were conducted in 330 households across 25 villages in Panna, and 361 households across 32 villages in Sariska. Decision tree and multinomial logistic regression analyses were employed to identify the explanatory variables associated with attitudes. In Panna, more respondents (52.12%) expressed negative opinions about tigers, as compared to positive (24.55%). Whereas in Sariska, more respondents had positive opinions (47.92%) than negative (34.90%). In both the sites, the most frequent reason given by the respondents for their negative attitude towards tigers was "fear." Regression modelling suggests that gender and education are key factors associated with the attitude of local communities towards reintroduced tigers. Other factors, specific to the reserves, were the age of the respondent, age of lost livestock, compensation received, and value of fodder obtained from the reserve. Community engagement must be integrated into conservation projects with a focus on educating women and the elderly about carnivores, protecting the traditional rights of local communities, and compensating for their losses.

Malviya, M., and Krishnamurthy, R. (2022). Multiscale spatially explicit modelling of livestock depredation by reintroduced tiger (Panthera tigris) to predict conflict risk probability. Global Ecology and Conservation, 40, e02313.

ABSTRACT

Spatial modelling of human-carnivore conflict has recently gained traction, and predictive maps have become a great tool to understand the distribution of present and future conflict risk. However, very few such studies consider scale and use appropriate spatial modelling tools. Objectives: We aimed to understand the ecological predictors of human-tiger (Panthera tigris) conflict and predict livestock predation risk by reintroduced tigers in Panna Tiger Reserve, Central India. By modelling livestock kill as a function of various tiger relevant ecological variables at multiple scales employing spatially explicit statistical tools. Methods: We used geostatistical modelling to create raster layers of covariates (prey, cover, human activities), following which

we did univariate scaling. We then modelled livestock loss by tiger using spatial Generalized Additive Model (geoGAM), predicted and mapped conflict risk probability. Results: We found that prey and shrub cover, both selected at a fine scale, were key ecological determinants of human-tiger conflict. Prey showed an inverse relationship with livestock predation and shrub nonlinear; livestock predation increasing with an increase in shrub cover but decreasing beyond a certain point. Thus, in habitats where optimum ambush cover is available but prey presence is low at fine-scale, carnivores are more likely to depredate domestic livestock since livestock have lost most of their anti-predator behaviours. Conclusions: Livestock kill by tiger is a culmination of predator choice and foraging tactics, and prey vulnerability and defence mechanism. The spatially explicit predation risk map produced in this study can guide adequate human-tiger conflict prevention measures.

Roy, A., Dash, S. K., and Sathyakumar, S. B. (2022). A Combination of Cultural Values and Economic Benefits Promote Tolerance Towards Large Mammals in a Hotspot of Human-Wildlife Conflicts in Eastern India. Human Ecology, 50(2), 321-329.

ABSTRACT

This study delves into the intricate socio-political dimensions of large mammal conservation, particularly in South Asia, where local communities face compounded challenges of HWC, limited livelihood opportunities, and minimal development policies. The creation of PAs, while beneficial for major keystone species, constructs unequal benefits and costs for different populations, often resulting in negative attitudes towards wildlife management. The concept of “conservation refugees” emerges as marginalized communities adapt to alternative livelihoods or challenge state-led conservation efforts. In this context, wildlife tourism emerges as a potential solution for fostering long-term coexistence. While wildlife tourism, both consumptive and non-consumptive, has been successful in Africa, it faces limitations and is predominantly state-administered in South Asia. The economic benefits derived from wildlife tourism play a crucial role in driving tolerance towards large mammals. The contrasting scenarios of wildlife tourism in Africa and South Asia prompt critical reflections on the mechanistic science and capitalist economy associated with conservation efforts. Some scholars question the concept of ‘selling nature for saving it’ and emphasize the importance of acknowledging the ‘sacred’ in conservation practices.

Saxena, A., and Habib, B. 2022. Crossing structure use in a tiger landscape, and implications for multi-species mitigation. Transportation Research Part D: Transport and Environment, 109, p.103380.

ABSTRACT

Crossing structures (CS) for wildlife are important mitigation strategies to offset impacts of roads on wildlife. However, information on CS use for the Indian subcontinent or the global tiger landscapes is scarce. We monitored wildlife use of nine CS on a national highway in a critical tiger conservation landscape in India. 21 wild mammals were found to use the CS within a span of 2 years. Tigers, wild dogs, most small mammals and ungulates were found to use CS that were near protected area, while ungulates and small mammals preferred CS with proximal vegetation cover. High species richness was observed under large CS. Similar capture rates for large carnivores between CS and adjacent habitat were observed. We found varied responses by structure generalists and specialists, a consequence of animal behavior and tolerance to human disturbance. We posit that animal behavior holds the key to designing and managing effective wildlife CS.

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATIONS

Carter, N. H., Pradhan, N., Hengaju, K., Sonawane, C., Sage, A. H., and Grimm, V. (2022). Forecasting effects of transport infrastructure on endangered tigers: a tool for conservation planning. PeerJ, 10, e13472 *http://dx.doi.org/10.7717/peerj.13472*.

ABSTRACT

The rapid development of transport infrastructure is a major threat to endangered species worldwide. Roads and railways can increase animal mortality, fragment habitats, and exacerbate other threats to biodiversity. Predictive models that forecast the future impacts to endangered species can guide land-use planning in ways that proactively reduce the negative effects of transport infrastructure. Agent-based models are well suited for predictive scenario testing, yet their application to endangered species conservation is rare. Here, we developed a spatially explicit, agent-based model to forecast the effects of transport infrastructure on an isolated tiger (Panthera tigris) population in Nepal's Chitwan National Park-a global biodiversity hotspot. Specifically, our model evaluated the independent and interactive effects of two mechanisms by which transport infrastructure may affect tigers: (a) increasing tiger mortality, e.g., via collisions with vehicles, and (b) depleting prey near infrastructure. We projected potential impacts on tiger population dynamics based on the: (i) existing transportation network in and near the park, and (ii) the inclusion of a proposed railway intersecting through the park's buffer zone. Our model predicted that existing roads would kill 46 tigers over 20 years via increased mortality, and reduced the adult tiger population by 39% (133 to 81). Adding the proposed railway directly killed 10 more tigers over those 20 years; deaths that reduced the overall tiger population by 30 more individuals (81 to 51). Road-induced mortality

also decreased the proportion of time a tiger occupied a given site by 5 years in the 20-year simulation. Interestingly, we found that transportation-induced depletion of prey decreased tiger occupancy by nearly 20% in sites close to roads and the railway, thereby reducing tiger exposure to transportation-induced mortality. The results of our model constitute a strong argument for taking into account prey distributions into the planning of roads and railways. Our model can promote tiger-friendly transportation development, for example, by improving Environmental Impact Assessments, identifying “no go” zones where transport infrastructure should be prohibited, and recommending alternative placement of roads and railways.

Dube, P. P. (2022). Should the Tigers be Protected?: A Survey on Opinions of Local Inhabitants of Bandhavgarh and Related Social Factors in the Conservation of Tigers. Indonesian Journal of Social and Environmental Issues (IJSEI), 3(1), 58-66. *http://dx.doi.org/10.47540/ijsei.v3i1.436Habitat Ecology*.

ABSTRACT

Increased human populations and the resulting encroachment of related anthropogenic land uses into natural landscapes which once afforded wildlife habitats is a global conservation concern. Of particular concern, are the human-wildlife conflicts perpetuated because of human populations' growth in the area where large carnivores occur? These increasing conflicts may further impact the conservation of carnivores because of public concerns for human health and safety and economic impacts on subsistence agriculture. In India, increased population growth has impacted the natural habitats for the Bengal tiger (Panthera tigris tigris) and the related conflicts have impacted efforts to conserve the species. To better describe the social factors that may affect large carnivore conservation in India, we surveyed the tiger-affected people, the relatives of the people killed by tigers, and the common villagers in the adjacent villages of Bandhavgarh National Park of Madhya Pradesh in India. All of our questionnaires are related to the protection of tigers and the reasons behind it. This study featured the first assessment and basic data for understanding Bengal tigers in the area of Bandhavgarh Forest.

Menon, V., Bhattacharyya, K., Sinha, S. K., Tiwari, S. K., and Kaul, R. (2022). Shared Landscapes: Optimising Conservation Strategies Using Tiger and Elephant Sympatry in India. Diversity, 14(12), 1055-1055. *http://dx.doi.org/10.3390/d14121055*.

ABSTRACT

Asian elephants (Elephas maximus) and tigers (Panthera tigris) share the same landscape in India. Elephants, which range over 239171 km^2, occupy 45.5% of the 433261 km^2 habitat that tigers inhabit. A shared landscape offers opportunities for careful, integrated management strategies with shared resources. Understandably, the species are treated differently in India, with Tiger Reserves being legal entities dedicated to the protection of tigers and their habitats, and Elephant Reserves being management units with no legal standing. With the additional disparities in financial supports to tiger reserves—which receive ten times more money than elephant reserves—it is obvious that the elephant reserves are being treated inequitably. Since the two species coexist the same landscapes, efforts to protect tigers can help to make up for elephant conservation gaps and optimize the use of conservation resources by tweaking a few management and policy practices.

Nittu, G., Shameer, T. T., Nishanthini, N. K., and Sanil, R. (2022). The tide of tiger poaching in India is rising! An investigation of the intertwined facts with a focus on conservation. GeoJournal, 88(1), 753-766. *http://dx.doi.org/10.1007/s10708-022-10633-4*.

ABSTRACT

Poaching and illegal trafficking are major threats to biodiversity, especially when endangered felids are concerned. Tigers are iconic animals, and there is huge demand for their body parts both in the national and international illegal markets. India forms the largest tiger conservation unit in the world and poaching is at its peak even though there are stringent laws and strict enforcement. In the present study, we analytically estimated the tiger seizure cases in India from 2001–2021 using newspaper archives as the main source of data. The data was geo-referenced to understand the details of seizure, demand, and locality. We statistically correlated the seizure rate with the density of tigers, tiger reserves, and various other socio-economic factors. Our result shows that skin, claws, bones, and teeth have more demand, with nails and teeth being the most preferred in local markets. The bones, flesh, and other parts were mostly seized in the border states of the north and eastern states. The intensity of seizures is very high in the states of Maharashtra, Karnataka, Tamil Nadu, and Assam. From our analysis, we predict four trade routes for the export of the seized parts: the Nepal-Bhutan border, Assam border, the Brahmaputra, and the Mumbai port. This corresponds to the five tiger conservation blocks in India, and we observed the seizure rate is high near the Western Ghats region, which has not yet been noticed. Apart from the seizure, we are unconcerned with the seizure's origin or the local trading routes. The study demonstrates the importance of identifying the source population using DNA methods and carefully enforcing the rules in area of poaching. We assert that current approaches are incapable of resolving the issue and that a more precise and effective forensic procedure capable of resolving the issue at the minute local level is critical for precisely tracing trade channels.

Pramod K. Yadav; Matthew T. J. Brownlee; Mohnish Kapoor. (2022). A systematic scoping review of tiger conservation in the Terai Arc Landscape and Himalayas. Oryx, 56(6): 888-896. http://dx.doi.org/10.1017/s0030605322001156.

ABSTRACT

In the last decade the tiger Panthera tigris population in the Terai Arc Landscape and Himalayas has increased, while populations in other countries have remained below their conservation targets. Although there has been some research on tiger conservation in the Terai Arc Landscape and the Himalayas, scientists and managers have not catalogued and characterized tiger research in the region, with empirical findings scattered among disparate document types, journals and countries. Without a review of the tiger research in the Terai Arc Landscape and Himalayan region, it is difficult to analyse or change conservation policies, develop adaptation strategies, prioritize research, allocate resources or develop conservation strategies potentially employable elsewhere. We therefore conducted a systematic scoping review to identify focal research areas, the spatial and temporal distribution of study sites, general publication trends, the extent of empirical studies, and gaps in tiger conservation research in this region (which spans Bhutan, India and Nepal). Since 2000, 216 studies have been published on issues associated with tiger conservation in the Terai Arc Landscape and Himalayas, with an increasing number over time. Most empirical studies have focused on tiger habitat, ecology and conflicts in protected areas in the region's foothills. There are research gaps in high-altitude landscapes, social science investigations, conservation economics, and policy and institutional analyses.

Vasudeva, V., Upgupta, S., Singh, A., Sherwani, N., Dutta, S., Rajaraman, R., Chaudhuri, S., Verma, S., Johnson, J.A., and Krishnamurthy, R. 2022. Conservation prioritization in a tiger landscape: is umbrella species enough?. Land, 11(3), p.371.

ABSTRACT

Conservation approaches in tiger landscapes have focused on single species and their habitat. Further, the limited extent of the existing protected area network in India lacks representativeness, habitat connectivity, and integration in the larger landscape. Our objective was to identify sites important for connected tiger habitat and biodiversity potential in the Greater Panna Landscape, central India. Further, we aimed to set targets at the landscape level for conservation and prioritize these sites within each district in the landscape as specific management/conservation zones. We used earth observation data to derive an index of biodiversity potential. Marxan was used to identify sites that met tiger and biodiversity conservation targets with minimum costs. We found that to protect 50% of the tiger habitat

with connectivity, 20% of the landscape area must be conserved. To conserve 100% of high biodiversity potential, 50% moderate biodiversity potential, and 25% low biodiversity potential, 55% of the landscape area must be conserved. To represent both tiger habitat and biodiversity, 62% of the total landscape area requires conservation or restoration intervention. The prioritized zones can prove significant for hierarchical decision making, involving multiple stakeholders in the landscape, including other tiger range areas.

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Ahmed, K., Khan, J. A. (2022). Food habit of Tiger (Panthera tigris) in Tropical Moist Deciduous Forest of Dudhwa National Park, Uttar Pradesh, India. International Journal of Ecology and Environmental Sciences, 48(6), 715-720. http://dx.doi.org/10.55863/ijees.v48i6.2612.

ABSTRCAT

Tiger (Panthera tigris) is an endangered felid on the IUCN list. Habitat loss, landscape fragmentation, prey depletion, and poaching have contributed to the decline of the tiger in its entire range in Asia. In India also, it survives only in well-protected tiger reserves and gone or decreased drastically in less-protected areas. The same situation is seen in the terai arc landscape. Thus, accurate knowledge of a species' diet is essential for effective conservation and is vital for conservation initiatives like habitat prioritization, protection, and restoration. Scats analysis was used to determine the food habit of tigers in the tropical moist-evergreen forest of Dudhwa National Park, northern India. A total of 116 scats were collected and analyzed. Scat contents were analyzed interms of the relative frequency of occurrence and the relative prey biomass consumed. A minimum of 14 prey species were identified. In terms of frequency of occurrence and biomass, the most important prey species were barasingha (Rucervus duvaucelii) and spotted deer (Axis axis), making up to 55% of biomass consumed. Domestic livestock contributed almost 10% to the diet of the tiger. The study revealed that tiger and leopard (Pantherapardus), the two main predators in Dudhwa Tiger Reserve differentiate their niches by segregating the available resources as 55% of the tiger diet comprises barasingha and spotted deer. On the other side, leopard mainly feeds on spotted deer and rodents and may avoid direct competition from the tiger by shifting the space and diet as revealed by another study in the same area.

Ahmed, K., Zehra, N., Khan, J. A. (2022). Food Habits of Tiger (Panthera tigris) in Reserve Forest of Uttarakhand, India. International Journal of Ecology and Environmental Sciences, 48(6). http://dx.doi.org/10.55863/ijees.2022.6721

Food availability and utilization are among the most critical factors influencing the distribution

of free-ranging animals. Little is known about the feeding habit of the tiger (Panther tigris) outside the tiger reserves. We collected data on the diet ecology of the tiger in the reserve forest of Kumaon Himalayas, Uttarakhand, India. Scats analysis was used to determine the food habit of the tiger. A total of 55 scats were collected and analyzed. The overall diet diversity of tigers in DWA (Shannon-Wiener Index H') was 2.923. Scat contents were analyzed in terms of both the relative frequency of occurrence and the relative prey biomass consumed. A minimum of 13 different prey species were identified, of which chital constituted 30.91% of the diet followed by sambar (21.82%). The wild prey constituted 77.36% of the diet, whereas domestic prey constituted 23.64% of the diet. Prey selectivity analysis indicated that selective predation by tigers was directed towards prey species with large body mass. This highlights the importance of adjacent forests around protected areas that helps large carnivores to disperse spatially and temporally during resource crunch, competition, and dispersal.

Biswas, S., Kumar, S., Bandhopadhyay, M., Patel, S. K., Lyngdoh, S., Pandav, B., Mondol, S. (2022). What drives prey selection? Assessment of Tiger (Panthera tigris) food habits across the Terai-Arc Landscape, India. Journal of Mammalogy, gyad069. *https://doi.org/10.1093/jmammal/gyad069*.

ABSTRACT

Large carnivores strongly shape ecological interactions within their respective ecosystems, but experience significant conflicts with humans across their range due to their specific ecological resource requirements. The Tiger (Panthera tigris) typifies the challenges faced by large carnivore species globally. India retains the majority of the global Tiger population with a substantial number occurring outside protected areas where they are prone to conflict through livestock predation and injury or death to people and Tigers. Tiger food habits was investigated across the Indian part of the Terai-Arc Landscape (TAL), a globally important Tiger conservation landscape, to understand Tiger prey selection patterns and hotspots of livestock predation-related conflict. 510 genetically confirmed Tiger feces were collected across the landscape and 10 wild ungulates and livestock as prey species were identified. Large-bodied species (Sambar, Swamp Deer, Nilgai, Chital, Wild Pig, and livestock) comprised ~94% of the diet, with Sambar, Chital, and livestock having the highest relative proportions. Habitat-specific (Shivalik-Bhabar and Terai) analyses indicate that prey selection is driven by prey abundance and body weight but not determined by protection status (protected areas vs non-protected areas). Results also suggest that PAs and non-PAs in the Terai region were more prone to livestock predation-related conflict. Careful management interventions with community involvement should be utilized to reduce such threats. In this study, we suggest long-term conservation plans including prey abundance estimation outside PAs, reduction of grazing pressures, and detailed records of Tiger mortalities with causal investigations to ensure future

conflict-free Tiger persistence across TAL.

Hussain, Z., Ghaskadbi, P., Panchbhai, P., Govekar, R., Nigam, P., Habib, B. (2022). Long-distance dispersal by a male sub-adult tiger in a human-dominated landscape. Ecology and Evolution, 12(9), e9307-. *http://dx.doi.org/10.1002/ece3.9307*.

ABSTRACT

Conservation of wide-ranging species and their movement is a major challenge in an increasingly fragmented world. Long-distance movement, such as dispersal, is a key factor for the persistence of population, enabling the movement of animals within and between populations. Here, we describe one of the longest dispersal journeys by a sub-adult male tiger (Panthera tigris) through GPS telemetry in Central India. We analyzed movement metrics, directionality, and space use during three behavioral stages of dispersal. We also used the clustering method to identify resting and kill sites (n = 89). T1-C1 dispersed a straight-line distance of 315 km over 225 days, moving an average of 8.38 km/day and covering a cumulative displacement of ~3000 km. Movement rate during post-dispersal was faster (mean = 0.47 km/h) than during dispersal (mean = 0.38 km/h) and pre-dispersal (mean = 0.13 km/h), respectively. The overall movement rate during the night (0.44 km/h) was significantly faster than during the day (0.21 km/h). Likewise, during dispersal, the movement was faster (mean = 0.52 km/h) at night than day (0.24 km/h). The average size of clusters, signifying resting and kill sites, was 1.68 ha and primarily away from human habitation (mean = 1.89 km). The individual crossed roads faster (mean = 2.00 km/h) than it traveled during other times. During the post-dispersal phase, T1-C1 had a space use of 319.48 km^2 (95% dBBMM) in the Dnyanganga Wildlife Sanctuary. The dispersal event highlights the long-distance and multiscale movement behavior in a heterogeneous landscape. Moreover, small forest patches play a key role in maintaining large carnivore connectivity while dispersing through a human-dominated landscape. Our study underlines how documenting the long-distance movement and integrating it with modern technology can improve conservation management decisions.

Panda, D., Mohanty, S., Allen, M. L., Dheer, A., Sharma, A., Pandey, P., Lee, H., Singh, R. (2022). Competitive interactions with dominant carnivores affect carrion acquisition of striped hyena in a semi-arid landscape of Rajasthan, India. Mammal Research, 68(2), 129-141. *http://dx.doi.org/10.1007/s13364-022-00663-1*.

ABSTRACT

Scavenging of carrion is an important ecological process that influences ecological communities and food webs. The competitive inter-and intra-specific interactions in terrestrial vertebrate

scavenger communities are likely to limit access to carrion for some scavengers, having direct impacts on their fitness by limiting energetic intake. Striped hyenas (Hyaena hyaena) are well-known facultative scavenger that co-exists with other carnivores (i.e., tigers, Panthera tigris; leopards, Panthera pardus; and golden jackals, Canis aureus) across the landscape. In this study, we assessed the competitive interactions among large carnivores having large sized body (i.e., striped hyenas, tigers, leopards) and a social group foraging mesocarnivore (i.e., golden jackal) through their carrion acquisition with special reference to striped hyenas' carrion acquisition in the semi-arid region of Rajasthan, India. We deployed camera traps at 14 carcass sites from 2020 to 2022 and considered three main aspects of scavenging behaviour (presence, total feeding time and mean feeding bout duration). We used Generalized Linear Models (GLMS) to understand the competitive interactions among large carnivores and mesocarnivores through their carcass consumption and scavenging efficiency. Our analyses showed that the tigers are dominant scavenger that monopolize carrion resources and reduce consumption time, and hence nutrition gained, of striped hyenas and the other carnivorous scavengers. But leopards and striped hyenas did not show any major negative interactions at carcasses, while both jackals and striped hyenas negatively affected each other's' carrion acquisition at carcasses, as a result, striped hyena's presence affected the carrion acquisition by jackals and also jackals affected the mean feeding bout duration of striped hyenas. Our results highlight the importance of functional traits in intraguild interactions and the potential effects of competition on carrion acquisition. Specifically, large carnivores that have specific traits i.e., large body size negatively affected the subordinate carnivores at carcasses, while the meso-carnivores that have specific traits i.e., social group foraging, negatively affect the carrion acquisition and energetics of solitary feeding striped hyenas.

Schoen, J.M., Neelakantan, A., Cushman, S.A., Dutta, T., Habib, B., Jhala, Y.V., Mondal, I., Ramakrishnan, U., Reddy, P.A., Saini, S., and Sharma, S. 2022. Synthesizing habitat connectivity analyses of a globally important human-dominated tiger-conservation landscape. Conservation Biology, 36(4), p.e13909.

ABSTRACT

As ecological data and associated analyses become more widely available, synthesizing results for effective communication with stakeholders is essential. In the case of wildlife corridors, managers in human-dominated landscapes need to identify both the locations of corridors and multiple stakeholders for effective oversight. We synthesized five independent studies of tiger (Panthera tigris) connectivity in central India, a global priority landscape for tiger conservation, to quantify agreement on landscape permeability for tiger movement and potential movement pathways. We used the latter analysis to identify connectivity areas on which studies agreed and stakeholders associated with these areas to determine relevant participants in corridor

management. Three or more of the five studies' resistance layers agreed in 63% of the study area. Areas in which all studies agree on resistance were of primarily low (66%, e.g., forest) and high (24%, e.g., urban) resistance. Agreement was lower in intermediate resistance areas (e.g., agriculture). Despite these differences, the studies largely agreed on areas with high levels of potential movement: >40% of high average (top 20%) current-flow pixels were also in the top 20% of current-flow agreement pixels (measured by low variation), indicating consensus connectivity areas (CCAs) as conservation priorities. Roughly 70% of the CCAs fell within village administrative boundaries, and 100% overlapped forest department management boundaries, suggesting that people live and use forests within these priority areas. Over 16% of total CCAs' area was within 1 km of linear infrastructure (437 road, 170 railway, 179 transmission line, and 339 canal crossings; 105 mines within 1 km of CCAs). In 2019, 78% of forest land diversions for infrastructure and mining in Madhya Pradesh (which comprises most of the study region) took place in districts with CCAs. Acute competition for land in this landscape with globally important wildlife corridors calls for an effective co management strategy involving local communities, forest departments, and infrastructure planners.

Sharma, U.K., Jarande, I., and Gupta, S.K. (2022). Analysis of Growth data of Physical Characteristics of Indian Tiger (Panthera tigris tigris) at Panna Tiger Reserve. Indian Forester, 148(10): 969-969. *http://dx.doi.org/10.36808/if/2022/v148i10/164686.*

Singh, R., Pandey, P., Qureshi, Q., Sankar, K., Krausman, P.R., and Goyal, S.P. 2022. Temporal variation in tiger population in a semi-arid habitat in India. Proceedings of the National Institute of Ecology of the Republic of Korea, 3(3), pp.154-164.

ABSTRACT

Understanding temporal variations in wildlife populations is a prerequisite for conservation planning of wide-ranging species such as tigers (Panthera tigris). We determined the temporal variation in abundance, population growth, and sex ratios at different age and sex stages for a tiger population in Ranthambhore Tiger Reserve, India from November 2007 to February 2011 using motion-sensing cameras. We identified 19 male and 21 female tigers from stripe patterns during 16,110 trap nights within an area covering 233 km^2. The annual abundance of the population varied from 34.9 (mean)±3.8 (SE) to 23.9±1.5, with a declining trend in the mean annual change of abundance (−12%). The density of adult females remained stable across the study duration, but the densities of adult males and non- breeding tigers fluctuated. The sex ratio was female-biased (0.58 males/female) for breeding tigers and male-biased (1.74 males/female) for non-breeding tigers. Our results reinforce the importance of long-term studies for monitoring the naturally occurring processes in populations to develop population indicators and identify reliable baseline information for conservation and management planning of

populations.

Tiwari, Y., Pandey, A., Taluja, J. S., and Vaish, R. (2022). Assessment of biometric evaluation of mandible in tiger (Panthera tigris). Cutting Edge Research in Biology, Vol. 1, 151–160. *https://doi.org/10.9734/bpi/cerb/v1/3015C*.

ABSTRACT

The present study was proposed to keep on record the gross anatomical features of mandible of tiger (Panthera tigris). It is important to understand that tigers play a vital role in the ecosystem, as they are a predator at the top of the food chain: the apex predator. Tigers (Panthera tigris) have evolved their jaw for predation and deadly bites. They shared their prey's throat with a huge canine, severing the nerves and blood vessels in the process and causing a swift collapse. Gross anatomical study was conducted on mandibles of 5 adult tigers (age more than 8 years) of either sex. It was found that the mandible was the largest and thickest bone of the skull weighing 350.9gm. It forms the lower jaw in tiger. The mandible was formed of 2 halves which were symmetrical to each other and were fused rostrally by symphysis. Each half was consisted of one horizontal rod like part, it was flattened mediolaterally and thicker anteriorly. The other part was vertical, short plate like dorsal border of symphysis was bearing alveoli for teeth. The alveoli of each corner were larger for canine and medial to these 3 small alveoli were present on each side for incisors. Only three cheek teeth were present on each side of the dorsal border of the mandible's horizontal portion, which had three alveoli. Large foramina in the mandible and brain were present. The results of this study show that the presence of three incisor teeth and a more pronounced mandibular angle distinguish the mandible of the tiger from that of the leopard on gross morphological and morphometrical characteristics. The information obtained in the present study would be useful for identification of bones of tiger and also as an aid in wildlife forensic.

Illegal trade (crime and poaching)

Nadarajan, A., Prithiviraj, S., Kumari, V., Rangasamy, K., and Jana, D. (2022). Illegal trade of canines: Identifying suspected samples of Tigers (Panthera tigris) and Bears (Melursus ursinus). International Journal of Multidisciplinary Research and Growth Evaluation, 531-540. *http://dx.doi.org/10.54660/anfo.2022.3.1.25*.

ABSTRACT

Poaching is one of the major reasons for declining heterotrophic wild populations attributed to illegitimate economic gain. It causes serious threats not only to the specific population but also generates a negative impact on the entire world population of wildlife. In recent years prohibited trade for canines is going through an upward trendline, adversely impacting a number of significant species of mammals. Increasing reports of canine seizures demand forensic inspection and thorough investigation of evidence for species identification. Though examination of canine samples through morphometric technique is acceptable, it falls short when the complete sample is not recovered for analysis. Thus, molecular analysis provides error-free and reliable proof of evidence in identifying species. This report investigates two separate canine seizures using combined approaches of morphometry and DNA analysis. Seizure 1 comprised a 10 years old broken canine sample and seizure 2 contained 4 canine samples (n=4). Morphometrically, physical examination, X-ray analysis and mensuration were undertaken. For molecular analysis, the mitochondrial regions of Cytochrome b (Cytb), 12S rRNA and 16S rRNA were targeted. BLASTn search and comparison with the genetic repository at Advanced Institute for Wildlife Conservation (AIWC) clearly indicated that seizure 1 belongs to Tiger (Panthera tigris) and seizure 2 belongs to Sloth bear (Melursus ursinus). To examine wildlife forensic case samples, both morphometric and molecular databases must be strengthened to increase the conviction rate while prosecuting under the Wildlife (Protection) Act, 1972 of India.

Photo from internet

Uddin, N., Enoch, S., Harihar, A., Pickles, R. S. A., Ara, T., and Hughes, A. C. (2022). Learning from perpetrator replacement to remove crime opportunities and prevent poaching of the Sundarbans tiger. Conservation Biology: The Journal of the Society for Conservation Biology, 37(2), e13997-. *http://dx.doi.org/10.1111/cobi.13997*.

ABSTRACT

Illegal wildlife trade (IWT) is one of the leading causes of the decline in high-value species. Crime reduction strategies to counter IWT can have unintended effects, with crime displacement occurring when offenders react to such interventions. Despite the value of understanding how and why displacement occurs for informing conservation strategies, examples in the literature are rare. Here we describe a case of perpetrator replacement following an intervention and draw lessons for conservation strategies for high-value species. Poaching for IWT threatens the Sundarbans tiger (Panthera tigris) with extinction. Pirate gangs were the dominant poacher type from 1980 to 2017, but following an extensive campaign, the Sundarbans was declared 'pirate free' in 2018. We interviewed 280 individuals, including 100 tiger poachers from 26 administrative unions bordering the Sundarbans and used interviewee responses to compare the poaching situation during and after the pirate era (1980-2018). In addition, we analysed the spatial distribution of tiger poachers among the unions and used crime script analysis of the dominant poacher type to identify intervention. The government of Bangladesh's successful counter-pirate campaign inadvertently removed the dominant tiger poaching type from the Sundarbans. However, a temporary reduction in poaching was rapidly cancelled out by the emergence of at least 32 specialist tiger poaching teams. With the risk of extortion and robbery from pirates gone, other groups increased the frequency of opportunistic and targeted tiger poaching. Based on a consensus of experts, we estimated that 341 tiger poachers of all types are active throughout the unions, with 79% of specialists concentrated in 27% of unions. The highly focused counter-pirate campaign reduced motivations and opportunities for piracy but left intact the opportunity structure and trade connections for tiger poaching, and with insufficient enforcement officers trading has flourished. We describe ten interventions targeting opportunities for poaching by specialist tiger poachers.

GENETICS

Aziz, M. A., Smith, O., Jackson, H. A., Tollington, S., Darlow, S., Barlow, A., Islam, M. A., and Groombridge, J. (2022). Phylogeography of Panthera tigris in the mangrove forest of the Sundarbans. Endangered Species Research, 48, 87-97. *http://dx.doi.org/10.3354/esr01188*.

ABSTRACT

Tigers Panthera tigris in the Sundarbans represent the only population adapted to living in mangrove forest habitat. Several studies, based on limited morphological and genetic data, have described the population as being differentiated from the Bengal tiger subspecies P. tigris tigris. The phylogenetic ancestry of the Sundarbans population has also remained poorly understood. We generated 1263 bp of mtDNA sequences across 4 mtDNA genes for 33 tiger samples from the Bangladesh Sundarbans and compared these with 33 mtDNA haplotypes known from all subspecies of extant tigers. We detected 3 haplotypes within the Sundarbans tigers, of which one is unique to this population and the remaining 2 are shared with tiger populations inhabiting central Indian landscapes. Phylogenetic analyses using maximum likelihood and Bayesian inferences supported the Sundarbans tigers as being paraphyletic, indicating a close phylogenetic relationship with other populations of Bengal tigers, from which the Sundarbans population diverged around 26000 yr ago. Our phylogenetic analyses, together with evidence of ecological adaptation to the unique mangrove habitat, indicate that the Sundarbans population should be recognised as a separate management unit. We recommend that conservation management must focus on sustaining this representative tiger population adapted to mangrove habitat while at the same time recognising that trans-boundary conservation efforts through reintroduction or exchange of individuals, to enhance genetic diversity, might be needed in the future as a last resort for population recovery.

Biswas, S., Bhatt, S., Sarkar, D., Talukdar, G., Pandav, B., and Mondol, S. (2022). Assessing tiger corridor functionality with landscape genetics and modelling across Terai-Arc landscape, India. Conservation Genetics, 23(5), 949-966.
http://dx.doi.org/10.1007/s10592-022-01460-8.

ASBTRACT

India led the global tiger conservation initiatives since last decade and has doubled its wild27tiger population to 2967 (2603-3346). The survival of these growing populations residing28inside the continuously shrinking habitats is a major concern, which can only be tackled29through focused landscape-scale conservation planning across five major extant Indian tiger30landscapes. The Terai-Arc landscape (TAL) is one of the 'global priority' tiger conservation31landscapes holding 22% of the country's wild tigers. We used intensive field-sampling,32genetic analyses and GIS modelling to investigate tiger population structure, source-sink33dynamics and functionality of the existing corridors across TAL. Genetic analyses with 21934tigers revealed three low, but sigficantly differentiated tiger subpopulations. Overall, we35identified Seven source and 10 sink areas in TAL through genetic migrant and gene flow36analyses. GIS modelling identified total 19 (10 high, three medium and six low

conductance)37corridors in this landscape, with 10 being critical to maintain landscape connectivity. We suggest urgent management attention towards 2707 sq. km. non-protected habitat, mitigation39measures associated with ongoing linear infrastructure developments and transboundary coordination with Nepal to ensure habitat and genetic connectivity and long-term41sustainability of tigers in this globally important landscape.

Maity, S., Singh, S. K., Yadav, V. K., Chandra, K., Sharma, L. K., and Thakur, M. (2022). DNA matchmaking in captive facilities: a case study with tigers. Molecular Biology Reports, 49(5), 4107-4114. *http://dx.doi.org/10.1007/s11033-022-07376-3*.

ABSTRACT

Background: Genetics driven interventions if adopted in conservation breeding projects may enhance the overall success by prioritizing breeding among genetically most competent individuals and delaying or completely diminishing the ill effects of inbreeding. Methods and results: In the present study, we investigated genetic make-up of 15 tigers housed at five different captive facilities of West Bengal in India and report the moderate level of genetic variation. We identified five tigers based on individual genetic attributes that may be prioritized for future breeding or animal exchange programmes. The occurrence of first and second order related individuals in captivity require management attention and they should be paired considering their immediate genetic background. Conclusion: Considering tiger as a case study, we highlight the use of genetic assessment and necessity to validate the studbook records in formulating adaptive management strategies for long-term conservation and management of species of interest.

Sharma, V., Sharma, C. P., Sharma, V., Goyal, S. P., Stevens, H., and Gupta, S. K. (2022). Age estimation of Tiger Panthera tigris (Linnaeus, 1758) and Lion Panthera leo (Linnaeus, 1758) (Mammalia: Carnivora: Felidae): applicability of cementum annuli analysis method. Journal of Threatened Taxa, 14(9), 21805-21810.
http://dx.doi.org/10.11609/jott.7727.14.9.21805-21810.

ABSTRACT

We describe the applicability of the cementum annuli analysis technique for estimating the age of Tiger Panthera tigris and Asiatic Lion Panthera leo using incisor teeth. We used I2 and I3 incisor teeth from the right mandible of Tiger and I2 and I3 from the left premaxilla of the Lion. The longitudinal sections of the teeth were prepared using an economical hand grinding technique with the help of sandpaper, followed by decalcification and staining with hematoxylin.

Two cementum layers were observed under the microscope in each of the I2 and I3 incisor teeth of the Tiger and six cementum layers were observed in each of the I2 and I3 incisor teeth of the Lion. The permanent incisors in Tiger and Lion erupt between 12 and 14 months of age; hence, we added one year to the counted number of cementum layers to estimate the final age of Tiger and Lion incisors. The age of Tiger and Lion incisors were estimated to be of three years and seven years, respectively. This method may be suitable for estimating other carnivores' age and applicable in wildlife forensic studies.

Shukla, H., Suryamohan, K., Khan, A., Mohan, K., Perumal, R. C., Mathew, O. K., Menon, R., Dixon, M. D., Muraleedharan, M., Kuriakose, B., Michael, S., Krishnankutty, S. P., Zachariah, A., Seshagiri, S., and Ramakrishnan, U. (2022). Near-chromosomal de novo assembly of Bengal tiger genome reveals genetic hallmarks of apex predation. GigaScience, 12, giac112.
https://doi.org/10.1093/gigascience/giac112.

ABSTRACT

The tiger, a poster child for conservation, remains an endangered apex predator. Continued survival and recovery will require a comprehensive understanding of genetic diversity and the use of such information for population management. A high-quality tiger genome assembly will be an important tool for conservation genetics, especially for the Indian tiger, the most abundant subspecies in the wild. Here, we present high-quality near-chromosomal genome assemblies of a female and a male wild Indian tiger (Panthera tigris tigris). Our assemblies had a scaffold N50 of >140 Mb, with 19 scaffolds corresponding to the 19 numbered chromosomes, containing 95% of the genome. Our assemblies also enabled detection of longer stretches of runs of homozygosity compared to previous assemblies, which will help improve estimates of genomic inbreeding. Comprehensive genome annotation identified 26,068 protein-coding genes, including several gene families involved in key morphological features such as the teeth, claws, vision, olfaction, taste, and body stripes. We also identified 301 microRNAs, 365 small nucleolar RNAs, 632 transfer RNAs, and other noncoding RNA elements, several of which are predicted to regulate key biological pathways that likely contribute to the tiger's apex predatory traits. We identify signatures of positive selection in the tiger genome that are consistent with the Panthera lineage. Our high-quality genome will enable use of noninvasive samples for comprehensive assessment of genetic diversity, thus supporting effective conservation and management of wild tiger populations.

MONITORING AND ASSESSMENT

Kumar, S., and Khan, J. A. (2022). Density Estimation of Tiger (Panthera tigris) in the Buffer Zone of Corbett Tiger Reserve. International Journal of Ecology and Environmental Sciences, 48(6). *http://dx.doi.org/10.55863/ijees.v48i6.2615*

ABSTRACT

Information about how many animals is in an area is essential for designing management strategies for endangered species such as tiger. Due to the tigers' elusive behaviour, high mobility and occurrence at low densities, it is difficult to determine an unbiased estimate of tiger abundance. To overcome the problem, biologists proposed camera trapping as an effective method to determine the abundance of the tiger. We used camera trapping to determine the abundance and density of the tiger in the buffer zone of the Corbett Tiger Reserve. An effort of 240 trap nights results in the identification of 20 individual adult tigers. Tiger density was estimated at 13.69±3.3 tigers per 100 km^2. Our estimation of tiger density highlighted the role of the buffer zone in landscape-level conservation of tigers and indicated that buffer zones can support the high density of tigers if appropriately managed. Anthropogenic activities exert enormous pressure on the buffer zone and it is imperative to have holistic management strategies for the long-term conservation of tigers in the human-dominated landscape of Corbett Tiger Reserve.

Pokhriyal, P., Tah, S., Kumar, M., Pandey, R., Sajjad, H., and Jain, R. (2022). Assessing Potential Habitat Suitability for Panthera tigris Using Multiple Grain Size and Different Ensemble Methods in Maximum Entropy Modeling. In M. Sahana, G. Areendran, and K. Raj (Eds.), Conservation, Management and Monitoring of Forest Resources in India. Springer, Cham. *https://doi.org/10.1007/978-3-030-98233-1_19*.

ABSTRACT

Habitat suitability is a foremost task in conserving wildlife and ecosystem. Rapid decline in wildlife and threat to their habitat due to unprecedented anthropocentric development and fragmentation of animal's habitat has increased likelihood of human-wildlife conflict. Rajaji Tiger Reserve (RTR), Uttarakhand, India, has the great potential to sustain the young migratory tigers. Present study aims to find out the suitability of Panthera tigris (tiger) at Chilla, Gohri, and Motichur ranges of RTR using presence-only species distribution modeling at multiple grain size. An ensemble model was developed with high precision. The influence of climatic variables for prediction of suitability of habitat for Panthera tigris was evaluated at 900 m grain size using the three approaches such as Maxent, Ecological Niche Factor Analysis, and

Bioclim. Results show that all the three models performed well with accuracy of more than 0.7 ROC value. Factors such as distance from settlement, distance from waterbody, distance from railway track, mean NDVI, and elevation were the primary contributes for all the models. Bioclimatic variables did not contributed significantly to the habitat suitability of the species in the RTR. The results signify that overreliance on the climatic variables and constraining model at coarse resolution is not required. Ensemble model was prepared using Maxent and Ecological Niche Factor Analysis. Only Maxent highlights the effect of different grain size, i.e., 30 m grain size was having better accuracy in comparison to 900 m grain size, whereas all other models were having more or less the same accuracy at different grain size. Ensemble model showed that out of the 335 km^2 area, approximately 105 km^2 was suitable at 30 m grain size species distribution model (SDM), whereas 96 km^2 area was suitable at 900 m grain size model. The analysis resulted that RTR has the potential to sustain Panthera tigris population. Regulatory mechanism along with better implementation of rules and regulation is required to be implemented by the government and concerned department along with better awareness among the local residents for sustaining the wildlife and their habitat.

Sahana, M., Areendran, G., and Sajjad, H. (2022). Assessment of suitable habitat of mangrove species for prioritizing restoration in coastal ecosystem of Sundarban Biosphere Reserve, India. Scientific Reports, 12(1), 20997-. *http://dx.doi.org/10.1038/s41598-022-24953-5*.

ABSTRACT

Mangrove forests being the abode of diverse fauna and flora are vital for healthy coastal ecosystems. These forests act as a carbon sequester and protection shield against floods, storms, and cyclones. The mangroves of the Sundarban Biosphere Reserve (SBR), being one of the most dynamic and productive ecosystems in the world are in constant degradation. Hence, habitat suitability assessment of mangrove species is of paramount significance for its restoration and ecological benefits. The study aims to assess and prioritize restoration targets for 18 true mangrove species using 10 machine-learning algorithm-based habitat suitability models in the SBR. We identified the degraded mangrove areas between 1975 and 2020 by using Landsat images and field verification. The reserve was divided into 5609 grids using 1 km gird size for understanding the nature of mangrove degradation and collection of species occurrence data. A total of 36 parameters covering physical, environmental, soil, water, bio-climatic and disturbance aspects were chosen for habitat suitability assessment. Niche overlay function and grid-based habitat suitability classes were used to identify the species-based restoration prioritize grids. Habitat suitability analysis revealed that nearly half of the grids are highly suitable for mangrove habitat in the Reserve. Restoration within highly suitable mangrove grids could be achieved in the areas covered with less than 75 percent mangroves and lesser anthropogenic disturbance. The study calls for devising effective management

strategies for monitoring and conserving the degraded mangrove cover. Monitoring and effective management strategies can help in maintaining and conserving the degraded mangrove cover. The model proves to be useful for assessing site suitability for restoring mangroves. The other geographical regions interested in assessing habitat suitability and prioritizing the restoration of mangroves may find the methodology adopted in this study effective.

Yadav, S.P., Mallick, A., Garawad, R., Sultan, S. and Singh, H. (eds) 2022. Technical Manual, Management Effectiveness Evaluation (MEE) of Tiger Reserves in India. National Tiger Conservation Authority, Government of India, New Delhi.

SUMMARY

The report discusses the importance of management effectiveness in achieving specific TR (Terrestrial and Freshwater) management objectives. It emphasizes the need for comprehensive planning and allocation of resources to meet these objectives, with funds being released on time and fully utilized. The 'Core Area' is highlighted as having extensive human and biotic

Sandesh Kadur

interference, which affects its management effectiveness. The report also mentions the role of NGOs like WWF and The Nature Conservancy in promoting the importance of management effectiveness and providing technical support. The WCPA Framework is mentioned, which views management as a process with six stages: establishing context, planning allocation of resources, management actions, producing goods and services, and resulting impacts or outcomes.

SUSTAINABLE SOLUTIONS AND TECHNOLOGY

Barman, N., Basu Roy, A., Basu Roy, R., and Barve, V. (2022). Understanding the Importance of social media as a Citizen Science Platform by Using Tiger Sighting Photographs from Facebook. Biodiversity Information Science and Standards, 6, e93924.
http://dx.doi.org/10.3897/biss.6.93924

ABSTRACT

Availability of scientific data and public support for conservation actions are necessary tools in mitigating conservation issues (Forrester et al. 2017). According to Falk and Dierking (2010), informal learning may be considered as an important avenue to engage the public with both science and nature. Ballantyne et al. (2007) reported informal learning is a key strategy to maintain support for conservation. Citizen science is considered a useful method for collecting ecological data at large scales involving non-professional volunteers in scientific research (Tulloch et al. 2013). Dickinson et al. (2012) reported it is an effective form of informal education about the natural world. Citizen science is a unique tool that can be used as a vehicle for direct experience of nature as well as offering informal education. Ubiquitous and inexpensive availability of internet-connected devices leads the public to engage in social media platforms at a large scale. People from various age groups from a variety of professions regularly use social media platforms like Facebook, Instagram, Flickr etc., to share their activities and creativity, as well as engage in fruitful discussions. Facebook alone enjoys more than 2.35 billion monthly active users (Abu Al-Haija et al. 2019). Photo sharing platforms can help in generating occurrence datasets (Barve 2014) as well as understanding the spatial distribution of various organisms (Jiménez Valverde et al. 2019). In our current study (Barman et al. 2022) we have selected Facebook as a source to collect data and analyze it from a conservation perspective. On Facebook, common people, travelers, amateur scientists, and corporations, share their photos and observations of nature in a structured or unstructured manner, knowingly or unknowingly. By compiling data from communities on Facebook, we have attempted to co-relate various parameters like time and space, to understand the status and abundance of the Bengal tiger (Panthera tigris tigris), which is one of the largest and charismatic carnivorous megafauna (Kumar 2021), and plays a key role in conservation management plans as an umbrella species

(Roberge and Angelstam 2004). Based on the dates that images were posted, we collected the data for a period of eighteen years (2004–2022). Individual tigers can be identified in the field based on their stripe pattern and are individually named by the staff of the forest department and tour naturalists. As the tiger is a critically endangered animal, it is important to have maximum data available for every individual, which can help in understanding, in a robust manner, the species ecology with respect to the landscape. Data compilation involved detailing the metadata recorded by the person posting and the comments on the post, as well as metadata evident from the photograph e.g., sex, life stage and activity. Geotagging was performed based on the place mentioned as the location of the photograph, to understand the extent of their area of mobility in a meaningful way. Data compiled for an individual tiger specimen, on the basis of photographs shared of various individuals over a period of time in social media platforms, has the potential to generate the same result involving radio telemetry, which is invasive and expensive in nature. It will then elevate the importance of photography as scientific documentation for ecological understanding and will generate interest through the participation in citizen science in conservation efforts involving megafauna. The sampled data shows a higher number of photographs available from protected areas that have a clear tourism protocol. We have also compared our distribution map, evolved out of this effort (Fig. 1) with the maps created by the Tiger Monitoring Cell*1 as a result of the Tiger Census activity, which happens in India every four years. This kind of cross referencing has the potential to bring out very interesting patterns in understanding coarse-scale ecological and geographic properties of a species (Peña-Aguilera et al. 2019, Soberón 2007).

Bhattacharya, S., Sultana, M., Das, B., and Roy, B. (2022). A deep neural network framework for detection and identification of Bengal tigers. Innovations in Systems and Software Engineering. *http://dx.doi.org/10.1007/s11334-021-00431-5*.

ABSTRACT

The Sundarban constitute the world's largest continuous mangrove forest comprising of the natural habitat of the Royal Bengal Tiger. There is an urgent need for developing a system that would help in monitoring, identifying, and counting the number of tigers not only ensuring the protection of the tigers but also prioritizing the least human disturbance and intervention to the physically inaccessible areas. In this paper, a system is proposed for the identification and detection of Royal Bengal Tigers using drone image-capturing with an active GPS and thermal detection. In this proposed work, the drone with an active GPS will help in monitoring the location and thermal scan to track the tigers. The captured image of the tiger by the drone will be passed to a Deep Convolutional Neural Network (DCNN) using YOLO and Faster RCNN that will help in the detection of the uncommon features of each tiger hence identifying and counting the number of tigers in a region.

ZOOLOGY AND ANIMAL WELFARE

Bhoj R Singh, Karikalan, M., Pawde, A. M., Karthikeyan, R., Sinha, D. K., Jaykumar, V., Yadav, A., and Agri, H. (2022). Antimicrobial Susceptibility Patterns of Bacteria Isolated from Aborted Foetuses of Lions (Panthera leo) and Tigers (Panthera tigris tigris). Acta Scientific Microbiology, 5, 116-123. *http://dx.doi.org/10.31080/asmi.2022.05.1122*.

ABSTRACT

Abortions are multietiological disorders of pregnancy interfering with reproduction, and bacteria are often the most common cause of in-utero death of foetii. The study was conducted to understand the bacteria associated with abortion and foetal death in big cats. Bacteriological analysis of aborted foetii samples (heart blood, stomach contents, liver, spleen, kidneys and lunges etc.) from lions (two) and tigers (four) revealed presence of bacteria of 11 different species viz.

Kolangath, S. M., Upadhye, S. V., Dhoot, V. M., Pawshe, M. D., Shalini, A. S., Tembhurne, P. A., and Kolte, S. W. (2022). Molecular Evidence of Hepatozoon felis Infection in Wild Captured Royal Bengal Tiger Cub (Panthera tigris tigris). Indian Journal of Animal Research, 1-6. *http://dx.doi.org/10.18805/ijar.b-4674*.

ABSTRACT

Tigers are protected under schedule I of the Wildlife Protection Act, 1972. The current report highlights the detection of Hepatoozoon felis in a tiger cub. The infection is transmitted by ingestion of infected tick, infected prey and carrion. It is subclinical in adults; however, the cubs and immunocompromised adults may show clinical symptoms. Concurrent infection with bacterial or viral infections may be fatal to the infected animal. Methods: Hepatozoonosis was detected by blood smear examination using Giemsa staining. A PCR targeting the 18S ribosomal RNA was used to confirm the infection. The amplicon was purified and sequenced using a sanger sequencer. The 18S ribosomal RNA fragment sequence was compared to the available sequences in NCBI database using the nucleotide BLAST Tool. Neighbour joining phylogenetic trees using the bootstrap method were constructed using MEGA X software. Result: The presence of an intermediate gamont stage in neutrophils was seen under high resolution. The 660 bp amplicon was purified, sequenced and analysed for identity using the nucleotide BLAST tool of NCBI. The sequence was found to be 99.32%, similar to Hepatozoon felis. The phylogenetic analysis by neighbour joining phylogenetic tree using the bootstrap method indicated similarity with other reported sequences of H. felis isolated from Asian Lions. The sequence, however, was very dissimilar to the previously reported H. felis isolated from

Royal Bengal Tiger. Considering the potential threat Hepatozoonosis can have in the wild, the prevalence must be estimated in prey base, sympatric cat species and arthropod vectors.

Patle, S., Singh, K. P., and Bagchi, D. (2022). Comparative analysis of wild and domestic carnivore animal hairs. IOP Conference Series: Earth and Environmental Science, 677, 042007. *http://dx.doi.org/10.21203/rs.3.rs-2245500/v1*

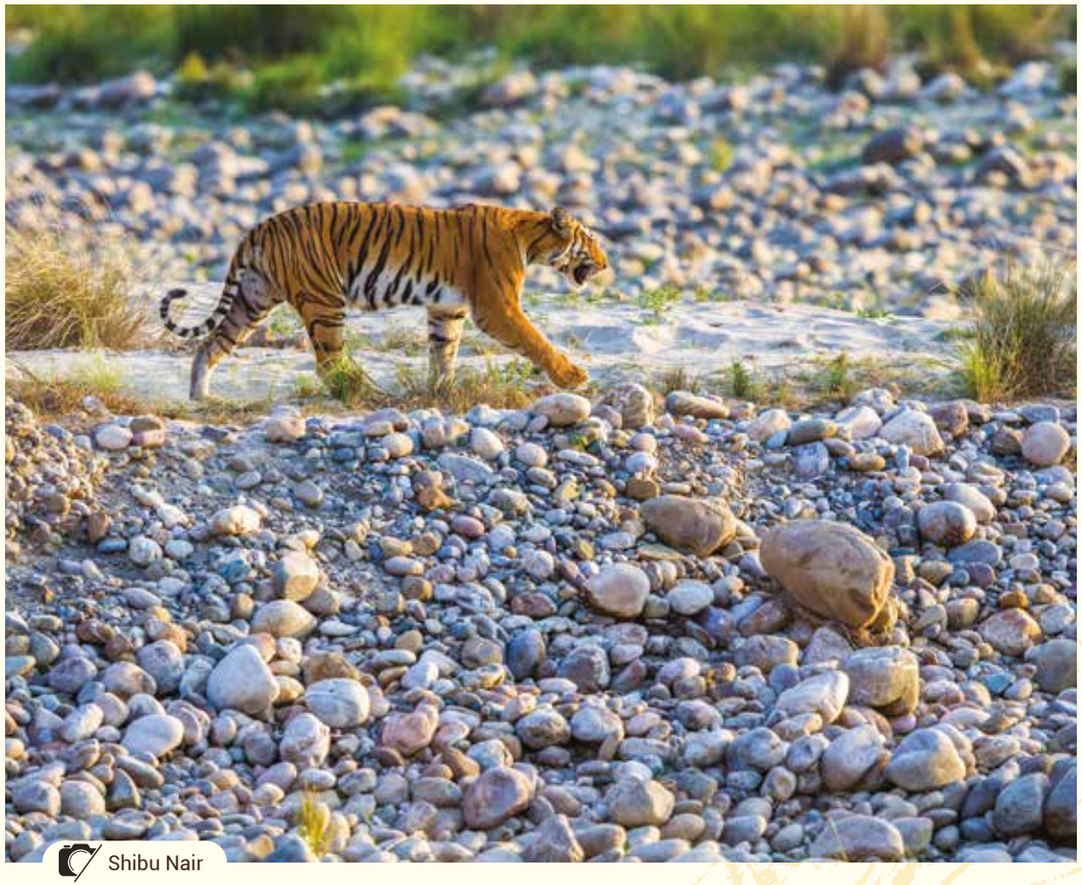
ABSTRACT

The present study was conducted to find out the microscopic characteristics and keratin protein pattern of hair of wild and domestic carnivores animals with the objective of species identification. Hairs have ability to remain unchanged chemically and histologically for years. For this study the shredded hair sample of Panther (Panthera pardus), Tiger (Panthera tigris), cat (felis catus), dog (Canis familiaris) were collected from school of wildlife forensic and health NDVSU, Jabalpur, (MP). Medullary pattern and cuticular characters were observed by binocular compound microscope under 40x – 100x magnification. The specific variations were observed in this study among hair color, texture, scale margin, scale distance, and scale pattern and variation in medullary pattern. These parameters of hair analysis play important role species identification.On the basis of microscopic characteristics species identification was done and further confirmed by extraction of keratin protein found between 40-60kDa by SDS-PAGE. The study emphasized that both the microscopic and SDS- PAGE analyses of guard hairs would be useful for recognition of an individual species particularly in forensic uses.

Simon, S., Alexander, J., Hind, P. A., Rajiv, T., Sooryadas, S., Dinesh, P. T., Umashankar, P. R., Easwaran, E. K., Anoop, R., Gouri, A. G., and Vijayakumar, V. D. (2022). A Novel Protocol for Medical Management of Cystic Endometrial Hyperplasia-Pyometra in White Tiger. Agricultural Science Digest - A Research Journal. *http://dx.doi.org/10.18805/ag.d-5510*.

ABSTRACT

Successful medical management of a serious form of Cystic Endometrial Hyperplasia-Pyometra (CEH-P) in a white tiger, with a combination of mifepristone, misoprostol, cloprostenol, cabergoline and enrofloxacin is discussed. Methods: A 14-year-old white tiger (Panthera tigris) belonging to the Zoological Garden, Thiruvanathapuram showed symptoms of gradual discomfort, dyspepsia and polydipsia for two weeks. There were no signs of oestrus for the previous two months and a serosanguinous vaginal discharge was also noticed. On ultrasonographic examination, uterine sacculations filled with fluid could be found which was suggestive of pyometra. Leukocytosis, neutrophilia, increased level of serum progesterone, anaemia, high ESR, persistent hyperproteinaemia and hyperglobulinaemia were evident on haematological examination. Considering the risks associated with performing OHE in large felids, medical management was planned. A combination of mifepristone, misoprostol, cloprostenol, cabergoline, enrofloxacin and supportive therapy were given along with strict and close monitoring by different experts on site or by utilizing telemedicine communication technologies. Periodic hematological examination, serum biochemistry, progesterone estimation and ultrasonographic evaluation were done to evaluate the progress of treatment. The progesterone values during the period of study ranged from 45.6 ng/ml at the commencement of treatment to a basal level of 0.73 ng/ml towards the end of treatment. Result: The animal had an uneventful clinical recovery. Considering the risks associated with performing OHE in large felids, medical management can be considered as a valuable option in treating CEH-Pyometra in wild felids. This being the first report of successful medical treatment of CEH-P in a large captive felid with a combination of antiprogestins, prolactin antagonists, prostaglandins and antibiotics, it is suggested that due consideration of such a treatment regimen is of great importance in large felids.



Shibu Nair

Rathika Ramasamy

INDONESIA

HUMAN WILDLIFE INTERACTION AND CONFLICT

Ardiantiono, Ardiantiono, Ardiantiono, Alfarisi, Afrizal Maula, Ishaq, Yanuar, Wijaya, Rhemawati, Septian, Reza, and Adhi Nurul Hadi. (2022). Media Content Analysis of Human-Predator Interaction in Indonesia. Jurnal Belantara, 5, 153–168. doi:10.29303/jbl.v5i2.874

ABSTRACT

Public tolerance toward predators is fundamental in their conservation and is highly driven by people's perception of the risk they may pose. Although predator attacks on humans are rare, they create lasting media attention, and the way the media covers them might affect people's risk perception. Understanding how mass media presents attacks and how this can affect perception will provide insights into potential strategies to improve coexistence with these species. We collected media reports of predator attacks on humans and examined their content. Almost half (41.5%) of the analyzed reports contained graphic elements. Differences in framing between species groups or species were found, with sharks and leopards having the highest proportion of graphic reports, whereas canids and bears had the highest number of neutral reports. This bias in coverage, instead of providing insights into the causes of these incidents and possible remedies, may provoke fear and decrease support for predator conservation.

Neo, W. H. Y., Lubis, M. I., and Lee, J. C. (2022). Settlements and plantations are sites of human–tiger interactions in Riau, Indonesia. Oryx, 57(4), 1-5.

Interactions between the Sumatran tiger Panthera tigris sumatrae and people (e.g. injury or loss of lives of people and tigers, evacuation of injured tigers, loss of livestock and sightings of tigers) can negatively affect the conservation of the subspecies. Land-use change in Sumatra has reduced habitat for tigers, forcing them into human-dominated landscapes and increasing the probability of interactions with people. Although the number of such interactions is high in South-east Asia, few studies have been published since 2000 and for Sumatra there is a lack of information regarding where these events occur. We collated data on human–tiger interactions in the province of Riau using web scraping of news sources published during 2010–2020, and mapped these data to village boundaries. We recorded 101 interaction events, with a total of 107 interactions, which we categorized into seven types (people injured or killed, livestock killed, sightings of tigers, tigers killed, injured or evacuated), in 78 villages. Most interactions with reported locations occurred close to settlements (35%), followed by in plantations (26%) and smallholdings (25%), with forests and forest edges comprising 14% of such events. Interactions were dominated by sightings of tigers, but severe interaction types (human death

or injury and attacks on livestock) were also reported. The mean annual number of human–tiger interactions was 4.6 during 2011–2017 and 21.3 during 2017–2020. We highlight the need for mitigation and prevention, such as establishing conflict mitigation teams, improving animal husbandry practices, and providing training and education on human–tiger interactions focused in plantations and settlements.

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Ash, E., Cushman, S. A., Redford, T., Macdonald, D. W., and Kaszta, Ż. (2022). Tigers on the edge: mortality and landscape change dominate individual-based spatially-explicit simulations of a small tiger population. Landscape Ecology, 37(12), 3079-3102. *http://dx.doi.org/10.1007/s10980-022-01494-w*

ABSTRACT

ContextReductions in the tiger's (Panthera tigris) range in Southeast Asia have been concurrent with large infrastructure expansion and landscape change. Thailand's Dong Phayayen-Khao Yai Forest Complex (DPKY), a landscape of tiger conservation priority, may be particularly vulnerable to such changes, necessitating investigations into effects on population dynamics. Objectives Evaluate relative effects of landscape change scenarios on the probability of tiger persistence in DPKY and sensitivity of predictions to spatially-explicit mortality risk, landscape resistance, and tiger population density.Methods We utilize individual-based, spatially-explicit population modelling to evaluate the trajectory of tiger population dynamics across 11 landscape change scenarios. Concurrently, we evaluate sensitivity of predictions to landscape resistance transformation, maximum population density, and spatially-explicit mortality across 20 generations.ResultsSpatially-explicit mortality risk dominated predictions of population persistence, frequently resulting in population declines/extinction. Adjustment of moderate mortality risk to slightly convex and concave forms shifted extinction rates from 46 to 12% and 85%, respectively. Holding mortality constant at moderate levels, strong negative effects were predicted in landscape change scenarios incorporating road expansion (46%-74% extinction) and construction of dams (52%). Strong negative effects of combined development persisted even when habitat restoration measures were applied (96% extinction). Adjusting resistance and maximum population density had marginal effects.Conclusions The high sensitivity and variability of predictions to spatial patterns of mortality risk suggest a population on a proverbial knife's edge. Our results underscore the importance of incorporating spatial patterns of mortality risk in population modelling, highlighting their potentially dominating influence on population dynamics and extinction risk.

Rahman, D. A., Santosa, Y., Purnamasari, I., and Condro, A. A. (2022). Drivers of Three Most Charismatic Mammalian Species Distribution across a Multiple-Use Tropical Forest Landscape of Sumatra, Indonesia. Animals, 12(19), 2722-2722. *http://dx.doi.org/10.3390/ani12192722*

ABSTRACT

Tropical Rainforest Heritage sites of Sumatra are some of the most irreplaceable landscapes in the world for biodiversity conservation. These landscapes harbor many endangered Asiatic mammals all suffering multifaceted threats due to anthropogenic activities. Three charismatic mammals in Sumatra: Elephas maximus sumatranus, Pongo abelii, and Panthera tigris sumatrae are protected and listed as Critically Endangered (CR) within the IUCN Red List. Nevertheless, their current geographic distribution remains unclear, and the impact of environmental factors on these species are mostly unknown. This study predicts the potential range of those species on the island of Sumatra using anthropogenic, biophysical, topographic, and climatic parameters based on the ensemble machine learning algorithms. We also investigated the effects of habitat loss from current land use, ecosystem availability, and importance of Indonesian protected areas. Our predictive model had relatively excellent performance (Sørensen: 0.81–0.94) and can enhance knowledge on the current species distributions. The most critical environmental predictors for the distribution of the three species are conservation status and temperature seasonality. This study revealed that more than half of the species distributions occurred in non-protected areas, with proportional coverage being 83%, 72%, and 54% for E.m. sumatranus, P. abelii, and P.t. sumatrae, respectively. Our study further provides reliable information on places where conservation efforts must be prioritized, both inside and outside of the protected area networks, to safeguard the ongoing survival of these Indonesian large charismatic mammals.

Suksavate, S., Dumsrisuk, Y., Indarabut, P., Godfrey, A., Saosoong, S., Harihar, A., Samad, I., Sukmasuang, R., and Duengkae, P. (2022). Spatial and Temporal Habitat Use by the Main Prey Species of Tigers in Two Protected Areas of Thailand's Southern Western Forest Complex. Environment and Natural Resources Journal, 20(6), 1-12. *http://dx.doi.org/10.32526/ennrj/20/202200046*.

ABSTRACT

Tigers (Panthera tigris) have disappeared from over 90% of their historical range, and extant populations face habitat loss, direct poaching, and prey depletion in otherwise suitable habitats. In Thailand, tiger numbers continue to decline due to prey depletion, yet a few strongholds remain. Recently, tigers have been detected in the Southern Western Forest Complex (sWEFCOM), following intensification of conservation efforts. However, there is still a lack of primary data on

the status of tigers and their prey in the sWEFCOM. To fill this knowledge gap, we conducted camera trapping surveys between 2019 and 2020 in Khuean Srinagarindra National Park (KSR) and Salakphra Wildlife Sanctuary (SLP). Located near a tiger source population in Thungyai Naresuan and Huai Kha Khaeng, these areas are potential areas for tiger recovery. In particular, our study assessed the status of prey, a prerequisite to the persistence and recovery of tigers. Based on relative abundance indices, time overlap and occupancy models, we analysed the effect of anthropogenic and ecological factors on the spatial and temporal habitat use of the main prey species. We highlight that anthropogenic factor impacted species-specific habitat relationships. Mainly, shifts in ungulate temporal and spatial habitat use was linked to human activities. These relationships, however, differed between the two protected areas. As tiger recovery depends on prey recovery, we suggest that increased conservation law enforcement and greater engagement with villages within and adjacent to protected areas are essential to minimising unsustainable resource use practices that currently affect prey.

Widodo, F. A., Imron, M. A., Sunarto, S., and Giordano, A. J. (2022). Carnivores and their prey in Sumatra: Occupancy and activity in human-dominated forests. PloS One, 17(3), e0265440-e0265440. *http://dx.doi.org/10.1371/journal.pone.0265440*.

ABSTRACT

Understanding the effect of anthropogenic disturbance, and its interaction with carnivores and their prey, is crucial to support the conservation of threatened carnivores, particularly in rapidly changing landscapes. Based on systematic camera-trap sampling of four protected areas in Riau Province of central Sumatra, we assessed the habitat occupancy and spatiotemporal overlap between people, potential carnivore prey, and four threatened species of medium-sized or large carnivores: Sumatran tigers (Panthera tigris sumatrae), Malayan sun bears (Helarctos malayanus), dholes (Cuon alpinus), and Sunda clouded leopards (Neofelis diardi). To assess spatial overlap of target species, we used single-species occupancy models and applied a Species Interaction Factor (SIF) to conditional two-species occupancy models. We also used kernel density estimation (KDE) to assess temporal overlap among these species. Our habitat use models showed that altitude (elevation) strongly influenced the occupancy of all large carnivores and potential prey species. Except for Sunda clouded leopards, the occurrence of large carnivore species was positively related to the spatial co-occurrence of humans (SIF > 1). In addition, we found that sun bears and dholes both exhibited high spatial overlap with tigers, and that sun bears alone exhibited high temporal overlap with people. Our findings contribute to an improved understanding of the contemporary ecology of carnivores and their prey in rapidly changing, southeast Asian landscapes. Such knowledge is important to the conservation and recovery of large carnivores in conservation hotspots that are increasingly dominated by humans across Sumatra, as well as globally.

GENETICS

Asrori, I., Tjong, D. H., Roesma, D. I., Syaifullah, Novarino, W., and Mansyurdin. (2022). DNA sexing of Sumatran Tiger (Panthera tigris sumatrae) based on amelogenin genes. World Journal of Advanced Research and Reviews, 14(3), 190-194. *http://dx.doi.org/10.30574/wjarr.2022.14.3.0482*.

ABSTRACT

Nowadays, forensic and wildlife research, especially the Sumatran tiger needs further research with a molecular approach. Molecular approaches are needed for forensic and wildlife research including for sex identity. This study used the amelogenin gene as a marker for identification based on previous studies of Felidae species. The sample used consisted of 10 blood samples from Sumatran tigers of known sex were collected by the Dharmasraya Sumatran Tiger Rehabilitation Center (PRHSD), one hair sample, and two bone samples whose sex was unknown were collected from Natural Resources Conservation Center West Sumatra (BKSDA). The PCR results of the amelogenin gene of the Sumatran tiger confirmed the sex of 10 samples of known sex's Sumatran tiger (Four male samples and six female samples), and Three samples of unknown sex were identified as females. Male was characterized by the electrophoresis appearance of two bands, while in female's only one band, with PCR product sizes of at least 190 bp for AMELY and at least 210 bp for AMELX.

Ashrifurrahman, Ashrifurrahman, Simamora, S., Ritonga, R., Novarino, W., Tjong, D. H., Rizaldi, R., Syaifullah, S., and Roesma, D. I. (2022). Sumatran tiger identification and phylogenetic analysis based on the CO1 gene: Molecular forensic application. Biodiversitas Journal of Biological Diversity, 23(4), 1788-1794. *http://dx.doi.org/10.13057/biodiv/d230410*.

ABSTRACT

Sumatran tiger identification and phylogenetic analysis based on the CO1 gene: molecular forensic application. Biodiversitas 23: 1788-1794. Wild animal hunting, especially in the Sumatran tiger (Panthera tigris sumatrae), has been caused the population decline. Regulation and law enforcement have been implemented even though it does not affect optimal because of the trickery of poachers and illegal traders. Sometimes, the evidence of P. t. sumatrae derivative products, for example, bones, nails, skins, hair, and other body parts, cannot be properly identified to raise the cases. However, genetic markers, such as the CO1 gene, have successfully identified illegal trafficking samples. This study used 20 samples, consisting of seven samples (four preserved hairs, two claws, one bone) that were suspected of P. t. sumatrae collected from illegal wildlife trade cases in West Sumatra, Indonesia. Other thirteen samples

were twelve blood and one hair of P. t. sumatrae samples were collected from the Dharmasraya Sumatran Tiger Rehabilitation Center (PR-HSD). All samples were isolated, Polymerase Chain Reaction (PCR), sequenced, and 999 base pairs (bp) of the CO1 gene sequences were analyzed. In addition, National Center for Biotechnology Information (NCBI) data sequences including two P. t. sumatrae sequences, four P. t. altaica sequences, one P. t. amoyensis sequence, one P. t. corbetti sequence, three P. pardus sequences, and one Felis catus sequence were collected for comparison and supporting data. The result confirmed that all samples in this study were P. t. sumatrae. We determined those depending on similarity value which was 99.60%-99.70% with P. tigris reference sequence (NC_010642.1) and 99.90%-100% with P. t. sumatrae (JF357969.1). Phylogenetic analysis supported species identification with average intraspecies sequence divergence was 0 to 0.4% and presented the monophyletic group. This study was the first and most recent report to use seized samples to identify P. t. sumatrae based on the CO1 gene in West Sumatra, Indonesia.

MONITORING AND ASSESSMENT

Asrizal Paiman, Paiman, A., Wulan, C., and Saputra, F. A. (2022). Efektivitas Keberhasilan Perekaman Harimau Sumatera (Panthera Tigris Sumatrae Pocock,1929) Menggunakan Kamera Jebakan Di Sptn I Sipurak Hook Taman Nasional Kerinci Seblat. Jurnal Silva Tropika, 5(2), 453-466. *http://dx.doi.org/10.22437/jsilvtrop.v5i2.17116*

ABSTRACT

This research aims to evaluate the results of trials of the effectiveness of the use of camera traps in knowing the problems and constraints that can be used in developing strategies and solutions to the problem of using camera traps for Sumatran tigers. Number of camera traps installed as many as 14 cameras. Installation of camera traps is distinguished by three mounting heights of soil that is 35 cm, 40 cm, 45 cm. Data analysis is done to collect data recording every camera trap with Sumatran tiger object. The results showed that there were 4 trap camera units that successfully recorded the Sumatran tiger, with the most effective recording activity of Sumatran tiger is at 45 cm height with 86%. There are 4 trap camera units that suffered damage and loss. The most effective mounting height in the recording process is the height of the 45 cm installation with 60% comparison.

Andy Foulton, Foulton, A., Yoza, D., and Oktorini, Y. (2022). Identifikasi Kelimpahan Jenis Satwa Mangsa Harimau Sumatra (Panthera Tigris Sumatrae) Menggunakan Kamera Jebak Di Resort Talang Lakat Taman Nasional Bukit Tiga Puluh. Wahana Forestra: Jurnal Kehutanan, 17(1), 55-68. *http://dx.doi.org/10.31849/forestra.v17i1.7402*.

ABSTRACT

Bukit Tiga Puluh National Park is one of the national parks in Indonesia used as a conservation area for the sumatran tiger. The existence of the sumatran tiger is not separate from the ability of forest areas to provide habitat components, such as sources of food, water, and shelter. This research aimed to identify the animal species and abundance of sumatran tiger prey species at Talang Lakat Resort, Bukit Tiga Puluh National Park. Data collected by camera trap as primary data and secondary data collected at the Bukit Tiga puluh National Park Hall. The data were analyzed using the formula of species abundance and encounter rate. Based on the data results, there are five types of sumatran tiger prey recorded by camera traps in 2020, such as Helarctos malayanus, Macaca nemestrina, Argusiana argus, Hystrix Brachyura, and Muntiacus muntjak. The prey species with the highest species abundance and RAI values in 2020 were Macaca nemestrina with a species abundance value of 40% and RAI 14 photos/day, while the lowest species abundance values were Helarctos malayanus with a value of 7% and RAI 5 photos/day.

Farhan Reza Pahlevi, Pahlevi, F. R., Susatya, A., and Suhartoyo, H. (2022). Study Of Wildlife Species Wealth Using Camera Trap in Sipurak Hook Area Kerinci Seblat National Park Area. Journal of Science Innovare, 5(2), 45-48. *http://dx.doi.org/10.33751/jsi.v5i2.6350*

ABSTRACT

Indonesia is known as one of the countries with the highest biodiversity in the world, this research was carried out from November 2020 to January 2021 in the Sipurak area, Merangin district, Jambi province. Camera traps are installed on tree trunks with an average height of 30 - 45 cm above the ground, the camera position is facing the path at a distance of 2.5 meters from the edge of the path and calculates the direction of light coming. The results of this study found 20 species of wild animals from 13 families, with a total of 201 independent event (IE) photos with the highest relative abundance of animals, namely, (Tupai javanica) of 12.95% and the lowest animal of Sumatran tiger (Panthera tigris sumatrae) by 0.72%.

Muhammad Atha Khalis, Khalis, M. A., Ar Rasyid, U. H., and Rahmi, E. (2022). Perilaku Harian Harimau Sumatera (Panthera tigris sumatrae) di Taman Margasatwa dan Budaya Kinantan Bukittinggi Sumatera Barat. Jurnal Ilmiah Mahasiswa Pertanian, 7(1), 770-778. *http://dx.doi.org/10.17969/jimfp.v7i1.18151*

ABSTRACT

Menurut IUCN (International Union for Conservation of Nature) harimau sumatera masuk

kedalam kategori terancam punah (Critical endangered). Harimau sumatera termasuk salah satu hewan dengan tingkat perawatan yang sulit dan sangat rawan kematian. Kematian tersebut tak terkecuali di wilayah kawasan ex-situ. Penelitian ini menggunakan metode observsi dan Focal animal sampling yang dilakukan dari pukul 08.00 sampai dengan pukul 17.00 WIB. Persentase perilaku harian harimau sumatera secara umum di Taman Margasatwa dan Budaya Kinantan (TMSBK) yaitu Boncel melakukan perilaku bergerak (43%), istirahat (39%), individu (12%), sosial (3%) dan agonistik (3%). Perilaku yang dilakukan Bujang Kinantan yaitu perilaku bergerak (17%), istirahat (64%), individu (14%), sosial (1%) dan agonistik (3%). Perilaku Bancah selama pengamatan yaitu perilaku bergerak (12%), istirahat (62%), individu (17%), sosial (10%) dan agonistik (0%). Perilaku Dara Jingga yaitu perilaku bergerak (5%), istirahat (79%), individu (15%), sosial (1%) dan agonistik (0%). Berdasarkan persentase perilaku harian harimau yang diperoleh dapat dilihat bahwasanya perilaku istirahat lebih dominan tinggi pada tiap individu, tetapi pada harimau Boncel memiliki persentase perilaku bergerak yang dominan, dikarenakan umur Boncel terbilang masih muda.Journal Daily Behavior of Sumatran Tigers (Panthera tigris sumatrae) at Kinantan Cultural and Wildlife Park Bukittinggi West SumatraAbstract. According to the IUCN (International Union for Conservation of Nature), the Sumatran tiger is in the critically endangered category. The Sumatran tiger is one of the animals with a difficult level of care and is very prone to death. These deaths are no exception in the ex-situ area. This research used observation method and Focal animal sampling which was conducted from 08.00 to 17.00 WIB. The percentage of daily behavior of Sumatran tigers in general at the Kinantan Wildlife and Culture Park (TMSBK) is that Boncel engages in moving behavior (43%), resting (39%), individual (12%), social (3%) and agonistic (3%). The behavior of Bujang Kinantan is moving behavior (17%), resting (64%), individual (14%), social (1%) and agonistic (3%). Bancah's behavior during the observation was moving behavior (12%), resting (62%), individual (17%), social (10%) and agonistic (0%). Dara Jingga's behavior is moving behavior (5%), resting (79%), individual (15%), social (1%) and agonistic (0%). Based on the percentage of daily behavior of tigers obtained, it can be seen that resting behavior is more dominant in each individual, but the Boncel tiger has a dominant percentage of moving behavior, because Boncel's age is relatively young.

Muhammad Gery Kemal, Kemal, M. G., Hadinoto, H., and Ikhwan, M. (2022). Kepadatan Satwa Mangsa Harimau Sumatera (Panthera tigris Sumatrae) di Area Konservasi Prof. Sumitro Djojohadikusumo. Jurnal Karya Ilmiah Multidisiplin (JURKIM), 2(2), 135-145. *http://dx.doi.org/10.31849/jurkim.v2i2.9695*.

Harimau Sumatera merupakan subspesies harimau yang masih bertahan hidup di Indonesia. Salah satu komponen utama yang dapat mempengaruhi kelangsungan hidup Harimau Sumatera adalah satwa mangsa. Populasi Harimau Sumatera saat ini mengalami penurunan dan keberadaannya sulit di temukan, hal ini disebabkan oleh kurangnya satwa mangsa akibat

rusaknya habitat dan perburuan liar. Penelitian ini bertujuan untuk mengidentifikasi satwa mangsa dan menghitung kelimpahan satwa mangsa. Metode yang digunakan pada penelitian ini adalah pengamatan terkonsentrasi (consentration count) yaitu pengambilan data yang dilaksanakan terkonsentrasi pada suatu titik yang diduga sebagai tempat perjumpaan satwa tinggi dengan menggunakan kamera jebakan. Kamera jebakan dipasang di 5 lokasi, pada batang pohon dengan ketinggian rata-rata 40-45 cm di atas tanah, posisi kamera menghadap ke jalur pada jarak 3 meter dari pinggir jalur. Data yang diidentifikasi adalah tingkat perjumpaan, kepadatan dan keanekaragaman jenis satwa mangsa. Ditemukan 11 jenis satwa mangsa Harimau Sumatera pada Area Konservasi Prof. Sumitro Djojohadikusumo. Tingkat perjumpaan satwa mangsa 346,5 per100 hari, kepadatan 0,0512 individu/ha dan indeks keanekaragaman jenis nya 1,4. Satwa mangsa yang mempunyai kepadatan tinggi yaitu Babi hutan dan Beruk masing-masing dengan nilai 0,0237 individu/ha dan 0,0187individu/ha.

ZOOLOGY AND ANIMAL WELFARE

Herdiana, H., Srie Rahayu, S. Y., and Retnowati, R. (2022). The Impact of The Covid-19 Pandemic On The Management Of The Sumatran Tiger (Panthera Tigris Sumatrae Pocock) In Conservation Institutions For The Public Interest (Case Study At Taman Safari Indonesia Cisarua Bogor And Ragunan Wildlife Park Jakarta). Journal of Science Innovare, 5(1), 9-15. *http://dx.doi.org/10.33751/jsi.v5i1.622*.

ABSTRACT

The World Health Organization (WHO) as a world health institution declared COVID-19 as a global pandemic on March 11, 2020 and Indonesia officially announced a confirmed case of COVID-19 infection on March 2, 2020. One of the tourist attractions affected by COVID-19 is the Conservation in the Public Interest such as safari parks, zoos and animal parks. This study aims to: analyze the management of the Sumatran Tiger in the Indonesian Safari Park Cisarua Bogor and the Ragunan Wildlife Park during the COVID-19 pandemic, analyze the steps to minimize the impact of the COVID-19 pandemic on the management of the Sumatran Tiger at the Indonesian Safari Park Cisarua Bogor and the Ragunan Wildlife Park. as well as formulating a strategy for managing the Sumatran Tiger in the face of a disease pandemic at the Taman Safari Indonesia Cisarua Bogor and the Ragunan Wildlife Park. The research method used is descriptive research method. The source of research data comes from primary data sources, namely the management of the Indonesian Safari Park Conservation Agency Cisarua Bogor and Ragunan Wildlife Park and secondary data sources obtained from literature studies. The data taken are the management of Sumatran tigers at the Cisarua Bogor Indonesian Safari Park and Ragunan Wildlife Park and the types of use of the Sumatran tiger in the Cisarua Bogor Indonesian Safari Park and Ragunan Wildlife Park. Field observations were carried

out to photograph and directly collect data on the condition of the Indonesian Safari Park Conservation Institute, Cisarua Bogor and Ragunan Wildlife Park, as well as the management of the Sumatran Tiger which includes aspects of management, manpower handling animals, and utilization and documentation studies. Processing of data from observations, interviews and documentation studies using descriptive qualitative analysis, and SWOT analysis. Based on the results of the study, that the operational management of the Sumatran Tiger at Taman Safari Indonesia Cisarua Bogor and the Ragunan Wildlife Park runs in accordance with the rules of animal management applied at the General Conservation Institute even though the COVID-19 pandemic has affected the income generated from visitor entrance tickets, especially for the park. Safari Indonesia Cisarua Bogor. The implication of this research is to minimize the impact of the COVID-19 pandemic on the operational management and protection of Sumatran tigers in the General Conservation Institute, the government together with the Indonesian Zoo Association and the managers of the General Conservation Institute need to immediately draw up an emergency plan for animal management, especially the Sumatran tiger, while maintaining based on aspects of animal welfare and compiling Standard Operating Procedures to prevent the spread of COVID-19.

Nareerat S., Chaiwattanarungruengpaisan, S., Thongdee, M., Suksai, P., Tangsudjai, S., Wongluechai, P., Suwanpakdee, S., Wiriyarat, W., Buddhirongawatr, R., Prasittichai, L., Skulpong, A., Akkapaiboon Okada, P., Puthavathana, P., and Paungpin, W. (2022). Serological and Molecular Surveillance for SARS-CoV-2 Infection in Captive Tigers (Panthera tigris), Thailand. Animals, 12(23), 3350-3350. *http://dx.doi.org/10.3390/ani12233350*

ABSTRACT

Coronavirus disease (COVID-19) is an emerging infectious disease caused by SARS-CoV-2. Given the emergence of SARS-CoV-2 variants, continuous surveillance of SARS-CoV-2 in animals is important. To monitor SARS-CoV-2 infection in wildlife in Thailand, we collected 62 blood samples and nine nasal- and rectal-swab samples from captive tigers (Panthera tigris) in Ratchaburi province in Thailand during 2020–2021. A plaque reduction neutralization test (PRNT) was employed to detect SARS-CoV-2 neutralizing antibodies. A real-time RT-PCR assay was performed to detect SARS-CoV-2 RNA. Our findings demonstrated that four captive tigers (6.5%, 4/62) had SARS-CoV-2 neutralizing antibodies against Wuhan Hu-1 and the Delta variant, while no SARS-CoV-2 RNA genome could be detected in all swab samples. Moreover, a low-level titer of neutralizing antibodies against the Omicron BA.2 subvariant could be found in only one seropositive tiger. The source of SARS-CoV-2 infection in these tigers most likely came from close contact with the infected animals' caretakers who engaged in activities such as tiger petting and feeding. In summary, we described the first case of natural SARS-CoV-2 infection in captive tigers during the COVID-19 outbreak in Thailand and provided seroepidemiological-based evidence of human-to-animal transmission. Our findings highlight the need for continuous surveillance of COVID-19 among the captive tiger population and emphasize the need to adopt a One Health approach for preventing and controlling outbreaks of COVID-19 zoonotic disease.

Ronas Salfitra, and Siagian, T. B. (2022). Pemeriksaan cacing saluran pencernaan Harimau sumatra (Panthera tigris sumatrae) di Kebun Binatang Kandi Sawahlunto. ARSHI Veterinary Letters, 6(2), 25-26. *http://dx.doi.org/10.29244/avl.6.2.25-26*

ABSTRACT

The purpose of this study was to identify gastrointestinal worms in Sumatran tigers (Panthera tigris sumatrae) in The Taman Satwa Kandi Sawahlunto, West Sumatra. The qualitative examination was carried out on male and female tigers with native and floating methods. The results showed that both of Sumatran tigers were positive for nematode eggs, namely ascarid and trichurid worm eggs. The type of adult worm that produces eggs for ascarid worms on the Sumatran tiger is Toxo-cara cati while the adult worm that produces eggs of trichurid worms is Trichuris trichiura.

Dimas Raihan Syahputra, and Siagian, T. B. (2022). Helminthiasis Identification on Bengal Tiger (Panthera tigris tigris). Jurnal Ternak, 13(2), 58-58. *http://dx.doi.org/10.30736/jt.v13i2.171*

Bengal tiger (Panthera Tigris) is a mammal in the big cat family. The decrease in the Bengal tiger population can be caused by helminth infections. The impact of helminth infection on Bengal tiger in short term does not show any clinical symptoms. The examination was carried out to identify gastrointestinal infections in Bengal tiger (Panthera Tigris) conducted at Maharani Zoo Lamongan, East Java. 5 samples of Bengal tiger feces were used for examination purpose. The examination of fecal samples on Bengal tigers was carried out qualitatively using the native method and the floating method. The results of the examination of 5 Bengal tigers at Maharani Zoo showed 1 positive for Ascarid eggs on native examination and on floating examination showed 2 positive samples for Strongylid eggs and 5 positive samples for Ascarid eggs. The percentage of helminthiasis in the Bengal tigers was 100% positive for helminth infection. The helminth infections at Maharani Zoo could be caused by damp cage, humid and dirty environment, food and water that were contaminated with helminth eggs.

LAOS

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Rasphone, A., Bousa, A., Vongkhamheng, C., Kamler, J. F., Johnson, A., and Macdonald, D. W. (2022). Diet and prey selection of clouded leopards and tigers in Laos. Ecology and Evolution, 12(7), e9067-. *http://dx.doi.org/10.1002/ece3.9067*.

ABSTRACT

In Southeast Asia, conservation of 'Vulnerable' clouded leopards (Neofelis nebulosa) and 'Endangered' tigers (Panthera tigris) might depend on the management of their preferred prey because large felid populations are limited by the availability of suitable prey. However, the diet of clouded leopards has never been determined, so the preferred prey of this felid remains unknown. The diet of tigers in the region has been studied only from one protected-area complex in western Thailand, but prey preferences were not determined. To better understand the primary and preferred prey of threatened felids, we used DNA-confirmed scats and prey surveys to determine the diet and prey selection of clouded leopards and tigers in a hilly evergreen forest in northern Laos. For clouded leopards, the primary prey was wild pig (Sus scrofa; 33% biomass consumed), followed by greater hog badger (Arctonyx collaris; 28%), small rodents (15%), and mainland serow (Capricornis sumatraensis; 13%; hereafter, serow). For tigers, the primary prey was wild pig (44%), followed by serow (18%), sambar (Rusa unicolor; 12%), and Asiatic black bear (Ursus thibetanus; 10%). Compared to availability, serow was positively selected by both clouded leopards (D = 0.69) and tigers (0.61), whereas all other ungulate species were consumed in proportion to the availability or avoided. Our results indicate that clouded leopards are generalist predators with a wide prey spectrum. Nonetheless, mid-sized ungulates (50-150 kg) comprised nearly half of their diet, and were the preferred prey, supporting a previous hypothesis that the enlarged gape and elongated canines of clouded leopards are adaptations for killing large prey. Because serow was the only ungulate preferred by both felids, we recommend that serow populations be monitored and managed to help conservation efforts for clouded leopards and tigers, at least in hilly evergreen forests of Southeast Asia.

MALAYSIA

MONITORING AND ASSESSMENT

Wahdaniyah, S., Noor Khalidah, K., Sabar, N. H., Kamarudin, N., Sanusi, R., Ahmad Razi, N., Lechner, A. M., and Azhar, B. (2022). Reforestation could bring native mammal species back in the tropical highlands. Tropical Ecology, 64(2), 380-390.
http://dx.doi.org/10.1007/s42965-022-00253-x

ABSTRACT

The rapid conversion of highland forests into agricultural areas has caused deforestation in Peninsular Malaysia. Since 2017, in the Cameron Highlands, the Forestry Department of Peninsular Malaysia has reforested degraded highland areas by planting native tree species. To date, little is known about the effect of highland reforestation on wild mammals in the region. This study aimed to examine the relationship between mammal detections and habitat variables in the reforested areas that previously had been coverted into intensively managed vegetable farms (for at least 10 years), using camera trapping over four forest reserves. Seven wild mammal species were detected across the study area, including conservation priority species such as the Sumatran serow (Capricornis sumatrensis), the otter civet (Cynogale bennettii), and the Asian golden cat (Catopuma temminckii). The wild boar (Sus scrofa) had the highest detection and leopard cat (Prionailurus bengalensis) was the most common carnivorous species at almost all of the study sites. Eight predictor variables determined mammal detection numbers in the highland reforestation areas. Mammal detections increased with elevation, sapling abundance, and number of trees with a DBH above 5 cm. While, detection numbers decreased with the number of fallen trees, palm abundance, and undergrowth coverage. Mammal detections varied with forest reserves and sampling months. Continuous monitoring is vital to understand long term trends in reforestation on wild mammal communities in highland areas, however, the outcome of our study is very promising and suggests reforestation could help reverse defaunation of highland forests in Peninsular Malaysia.

MYANMAR

MONITORING AND ASSESSMENT

Shwe, N. M., Grainger, M., Ngoprasert, D., Aung, S. S., Grindley, M., and Savini, T. (2022). Anthropogenic pressure on large carnivores and their prey in the highly threatened forests of Tanintharyi, southern Myanmar. Oryx, 57(2), 262-271.
http://dx.doi.org/10.1017/s0030605321001654.

ABSTRACT

The Tanintharyi Region in southern Myanmar is rich in biodiversity yet is facing threats from varying degrees of anthropogenic pressure. In this research we examine how anthropogenic pressures are influencing large carnivores (tiger Panthera tigris , leopard Panthera pardus and dhole Cuon alpinus) and their major prey species (wild pig Sus scrofa , muntjac Muntiacus spp., sambar Rusa unicolor , gaur Bos gaurus and banteng Bos javanicus) in the Lenya Reserved Forest and adjacent areas of Sundaic forest. We used data from camera-trap surveys during May 2016–March 2018 and logistic regression to analyse the relationships between the presence of large carnivores and explanatory variables such as human disturbance, landscape variability and changes in prey distribution. Tiger presence was positively associated with the occurrence of gaur and distance to villages. The occurrence of prey did not explain the detection of leopards in the study area. We suspect this was because leopards have a broad diet, including arboreal primates, and their prey was not fully recorded in our camera-trap survey. Dholes were positively associated with wild pigs and the total number of prey but not associated with forest type and landscape variables. To restore the carnivore population and conserve the biodiversity of this area, effective protection of predators and habitat management for large ungulates are crucial.

NEPAL

HUMAN WILDLIFE INTERACTION AND CONFLICT MITIGATION

Kandel, K., Sharma, C. M., and Pokheral, C. (2022). Human-tiger (Panthera tigris) conflict: status and trend in the Chitwan National Park, Nepal.
http://dx.doi.org/10.22541/au.165367123.31682399/v1.

ABSTRACT

This study explores an understanding of human-wildlife conflict (HWC) focused on tiger, particularly the status and trend of human-tiger conflict (HTC), in three major areas of Chitwan National Park (CNP); Ayodhyapuri, Patihani and Meghauli VDCs. A set of questionnaire survey was conducted in 98 households [Ayodhyapuri (38), Patihani (30) and Meghauli (30)]. Additionally, key informant interviews were conducted and official records of CNP, National Trust for Nature Conservation (NTNC) and Department of National Park and Wildlife Conservation (DNPWC) during month of June- July, 2017 were referred. Records from 2003 to 2015 at CNP shows that highest HTC was recorded in the year 2003-2004 (235 cases), out of which human casualties were 22 (4 injured and 18 killed). The trend has declined thereafter with the lowest conflict recorded in the year 2013-2014 (17 cases), out of which human casualties were 6 (4 injured and 2 killed). A significantly higher human-tiger interaction was recorded in Ayodhypuri compared to other two study sites ($\chi 2 = 7.88$; d.f. = 2; $p = 0.02$). However, a contradictory trend was obtained based on our survey owing to the long compensation procedure (51.02%), less compensation (30.61%) and weak information flow (18.36%). Besides, the development of dense community forest lured the tigers to the nearby buffer zone causing conflicts with tigers. Nevertheless, the perception of respondent relative to tiger conservation was found to be positive. Conservation education, awareness programs along with adequate and prompt compensation against damages coupled with regular/timely monitoring of tigers may help to reduce human-tiger conflicts.

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATIONS

Ghimire, P. (2022). Conservation of Tiger Panthera tigris in Nepal: a review of current efforts and challenges. Journal of Threatened Taxa, 14(9), 21769-21775.
http://dx.doi.org/10.11609/jott.7011.14.9.21769-21775

ABSTRACT

The Tiger Panthera tigris is one of the most charismatic and well known Asian big cats. In

the lowlands of Nepal, Tigers along with the Greater One-Horned Rhinoceros Rhinoceros unicornis and the Asiatic Elephant Elephas maximus serve as flagship species gathering global conservation attention. Current surveys estimate a population of 235 tigers in Nepal. Tigers in Nepal are strictly protected in five protected areas located in the lowlands and their adjoining forest areas which cover 7,668.20 km^2. However, over the last century, tiger population and their distribution range drastically declined with the species heading towards extinction. The long-term survival of this charismatic species is challenging largely due to the loss and fragmentation of habitat, climate change, increasing human-wildlife interface and poaching for illegal trade of body parts. In response to this, the Government of Nepal along with conservation agencies and local communities have proceeded to execute various conservation initiatives both at national and international level. This paper tries to scrutinize the current status of tiger population, conservation efforts, and existing challenges to conserve tiger species in Nepal.

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Lamichhane, S., Pun, P., Thanet, D. R., Regmi, P. R., Maharjan, A., and Lamichhane, B. R. (2022). Dietary composition and prey preference of Royal Bengal Tiger (Panthera tigris tigris, Linnaeus 1758) of Parsa National Park, Nepal. European Journal of Ecology, 8(1), 38-48.
http://dx.doi.org/10.17161/eurojecol.v8i1.15466

ABSTRACT

Carnivore diet studies insight on the health of the forest. The diet and prey preference of tigers of Parsa National Park (PNP) was studied from Nov-2019 to Feb-2020. The ratio of scat sample analyzed per tiger was 3.5 scats per tiger. The scat analysis identified 10 prey species and 81 prey items in the tiger's diet. Spotted deer was the frequently killed prey species followed by wild boar and barking deer. In terms of biomass consumption, large-sized sambar was on the top. The average weight of the prey killed was 138 kg. The tiger strongly selected sambar and weakly selected small-sized barking deer. Medium-sized prey species (spotted deer and wild boar) were neglected. The large-sized prey and their density were the keys to increasing the tiger population in PNP. The absence of livestock in PNP's tiger diet suggests it to be a potential area for tiger conservation.

MONITORING AND ASSESSMENT

DNPWC and DFSC. (2022). Status of Tigers and Prey in Nepal 2022. Department of National Parks and Wildlife Conservation and Department of Forests and Soil Conservation. Ministry of Forests and Environment, Kathmandu, Nepal.

ABSTRACT

Nepal, a signatory to the St. Petersburg Declaration of 2010 aimed at doubling the tiger population by 2022, has made significant strides in tiger conservation. Implementing strategic conservation plans, adopting a landscape conservation approach, and establishing key national parks have played crucial roles in this success. The periodic assessments conducted since 2009 reflect the commitment to tiger conservation. The fourth nationwide survey conducted between December 2021 and April 2022 involved extensive efforts, utilizing camera traps, line transects, and advanced technologies. Key findings include: Tiger Population Growth: The tiger population in Nepal has shown promising growth. The nationwide survey estimated 355 individuals, reflecting an approximate 51% increase since 2018. This achievement signifies Nepal's success in doubling its tiger population. Habitat Occupancy: Tigers were found to occupy an area of approximately 9,653 km², with protected areas showing higher occupancy (~0.86) compared to areas outside protected zones (~0.38). This suggests opportunities for further increase through targeted management. Spatial Distribution: Camera traps identified tigers in 16 districts, highlighting their presence across the country. The distribution varied, with protected areas having higher concentrations. Protected Area-wise Population: Spatial capture-recapture estimates revealed tiger populations in key national parks. Parsa, Chitwan, Banke, Bardia, and Shuklaphanta National Parks were estimated to have 41, 128, 25, 125, and 36 tigers, respectively. Prey Density: Prey species, including deer, antelopes, wild boar, gaur, and primates, showed positive trends in density. Prey density estimates per km² in protected areas ranged from 33 to 146, reflecting a healthy ecosystem. Conservation Strategies: Positive outcomes were attributed to improved protection, enhanced management measures, increased connectivity, and community support. To sustain these gains, future interventions should focus on protecting tigers outside reserves, managing human-tiger conflicts, and enhancing prey density, particularly for larger species. Nepal's success in achieving the St. Petersburg target underscores the importance of collaborative conservation efforts, community involvement, and adaptive management strategies. Continued research and engagement with local communities will be vital for maintaining and furthering these conservation successes.

RUSSIA

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATIONS

Mukhacheva, A. S., Bragina, E. V., Miquelle, D. G., Kretser, H. E., and Derugina, V. V. (2022). Local attitudes toward Amur tiger (Panthera tigris altaica) conservation in the Russian Far East. Conservation and Society, 20(4). *http://dx.doi.org/10.5281/zenodo.6800046*.

ABSTRACT

Public support is a necessary component of large carnivore conservation. We analysed public opinion on Amur tigers, Panthera tigris altaica, in Russia's Far East, the northernmost stronghold of the world's rarest big cat. We surveyed 1035 people in 5 settlements at increasing distances to tiger habitat. Overall support for tiger conservation was high (95.4%), although lower in more rural communities—especially among hunters—with limited socio-economic opportunities, and where tigers pose a higher perceived threat to livelihoods. Nearly 20% of respondents supported lethal removal of individual problem tigers that posed a threat to humans. Non-hunters, higher-income earners, and people who rated their communities' pre-college education positively showed less support for even such restricted killing of tigers. Hunters were more likely to support the idea of legalizing tiger hunting (hunting tigers is a felony in Russia), and less likely to attribute tiger decline primarily to poaching. Despite strong support for tiger conservation in both urban and rural settings, a subset of the local populace is still engaged in poaching and trading of tigers, making improved situational crime prevention a needed focus of future efforts, alongside behaviour change campaigns promoting active resistance to poaching among tiger supporters.

MONITORING AND ASSESSMENT

Yachmennikova, A., Zhu, S., Kotlov, I., Sandlersky, R., Yi, Q., and Rozhnov, V. (2022). Is the Lesser Khingan Suitable for the Amur Tiger Restoration? Perspectives with the Current State of the Habitat and Prey Base. Animals, 13(1), 155-155. *http://dx.doi.org/10.3390/ani13010155*.

ABSTRACT

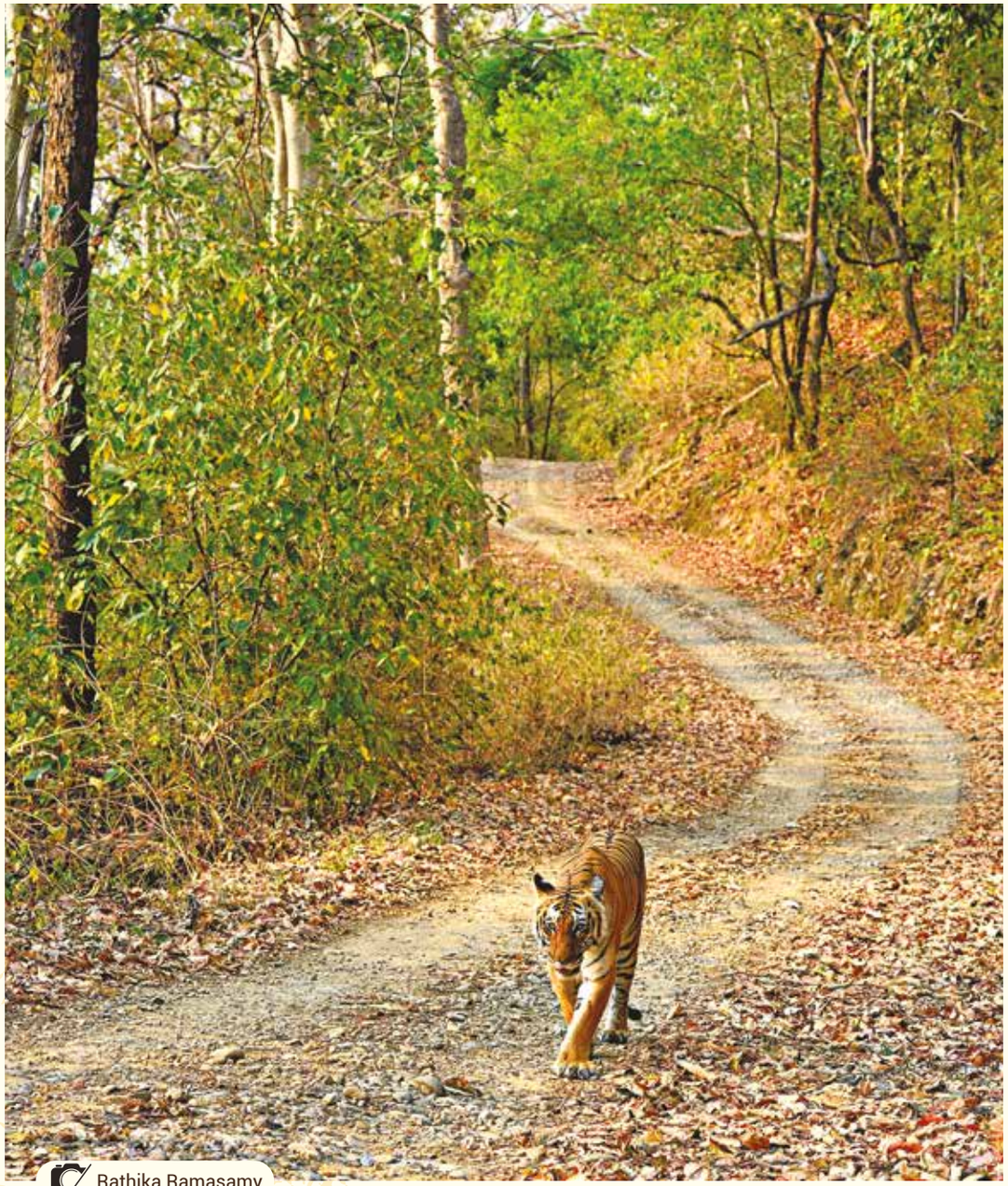
The Amur tiger (Panthera tigris) has a status of being endangered on the world's IUCN red list. The northwestern part of its range is situated in Russia and China, where tigers were exterminated by humans in the 1950–1970s. To restore tiger population within a historical range, an estimation of the habitat suitability is firstly needed. The Lesser Khingan mountains (Heilongjiang) was analyzed. Habitat types were mapped by satellite images analysis and field proven. The potential habitats of the main tiger's prey species (wild boar (Sus scrofa), roe deer (Capreolus pygargus), and red deer (Cervus elaphus xanthopygus) were also assessed. Maximum entropy and linear discriminant analysis methods were applied and compared for species distribution modeling (SDM). Species distribution maps were used to design an ecological network. The fragmentation of habitat patches was evaluated by spatial ecological metrics. The habitat patches with the best metrics were assigned as cores for the ecological network, which were connected by calculated corridors. The least cost distance method (based on distance to roads and settlements) was used. The recovery of the Amur tiger in habitats of China's Lesser Khingan is shown to be possible. Types of habitats were calculated as natural corridors for moving tigers. They are mainly located at the forests' edges and characterized with various canopy structures and high variability in the tree species composition. Three potential transboundary corridors are described: (a) foothills and low mountains of the northern Lesser Khingan; (b) connection between the southeast Lesser Khingan and the western part of the Wandashan mountain system; and (c) corridor within foothills and lowmountains of the eastern part of Lesser Khingan. It is recommended to establish protected areas for the important tiger core habitats, and the main optimal ways for their migrations are described during the current investigation. Moreover, it is necessary to implement habitat recovery activities for key areas.

Voronova, A. N., Vainutis, K. S., Tabakaeva, T. V., Sapotsky, M. V., Kakareka, N. N., Volkov, Y. G., Galkina, I. V., and Shchelkanov, M. Y. (2022). Molecular identification of the trematode P. ichunensis stat. n. from lungs of Siberian tigers justified reappraisal of Paragonimus westermani species complex. Journal of Parasitic Diseases: Official Organ of the Indian Society for Parasitology, 46(3), 744-753. *http://dx.doi.org/10.1007/s12639-022-01481-7*.

ABSTRACT

Flukes from the genus Paragonimus Braun, 1899 are medically important foodborne trematodes predominantly occurring throughout Asian countries. Providing molecular genetic characteristics based on ITS2 and partial 28 S rDNA of the paragonimids from the Russian Far East, Northeast, South, and Southeast Asian countries, we performed a partial reappraisal of Paragonimus westermani species complex. Members of this complex are genetically distinct worms with different divergence times and explosive expansion during Miocene-Pliocene epochs. We confirm the taxonomic status as valid species for P. ichunensis stat. n. (from the Russian Far East and Northern China), and P. filipinus (from the Philippines), which were previously considered subspecies of P. westermani, and reinstated the species name P. pulmonalis (from Japan). We suggest considering the worms from South Korea the Korean variety of P. ichunensis, because Korean specimens are sister and genetically closest to P. ichunensis from Northeast China and Primorsky region of Russia. Worms from South (India (type 2), Sri Lanka), Southeast (Malaysia, Vietnam, Thailand (types 1 and 2)) and East Asia

(Taiwan) were left in the paragonimid systematics as Paragonimus sp. We propose to consider Indian worms of type 1 as true P. westermani, but in further revisions, due to the lack of holotype and unknown exact type locality, new type specimens (neotype) should be established.



Rathika Ramasamy

TRANSBOUNDARY

MONITORING AND ASSESSMENT

Bijlmakers, J., Griffioen, J., and Karssenberg, D. (2022). Environmental drivers of space-time dynamics in floodplain vegetation: grasslands as habitat for megafauna in Bardia National Park (Nepal). *http://dx.doi.org/10.5194/bg-2022-129*

ABSTRACT

Disturbance-dependent grasslands, often associated with hydromorphological and fire dynamics, are threatened, especially in subtropical climates. In the Nepalese and Indian Terai Arc Landscape at the foot of the Himalayas, natural and cultural grasslands serve a viable role for rhinos (Rhinoceros unicornis) and the prey of the Royal Bengal tiger (Panthera tigris). The grasslands are vulnerable for encroachment of forest. We aimed to establish the effects of environmental drivers, in particular river discharge, river channel dynamics, precipitation, and forest fires, on space-time dynamics of these grasslands. The study area is the floodplain of the eastern branch of the Karnali River and adjacent western part of Bardia National Park. We created two annual time series of land cover with the use of field data, remotely sensed LANDSAT imagery and a supervised classification model. Additionally, we analysed aerial photographs of 1964 and the pattern of grassland patches. From 1964 to 2019, grasslands saw a transition to forest and grassland patches decreased in size and number. Outside the floodplain, successional setbacks of grassland coincide with extreme precipitation events. Within the floodplain, successional setbacks of grassland correlate with the magnitude of the annual peak discharge. However, this relationship is absent after 2009 due to a westward shift of the main discharge channel of the bifurcated Karnali River with a vast expansion of alluvial tall grasslands (Saccharum spontaneum dominant) as consequence. Since 2009, hydromorphological processes in the floodplain have become more static. This is supported by an observed decrease in water coverage (-53 %) in the dry season, an absence of successional setbacks, and decreased morphodynamics of river channels. For forest fires, the surface area that annually burns is observed to be more variable in recent years and the maximum extent affected by fires is in an increasing trend. Because the hydromorphological processes in the floodplain have become more static, other sources of disturbances – ephemeral streams, anthropogenic maintenance, grazing and fires – are more paramount to prevent encroachment of grasslands. Altogether, our findings underscore that a change in the environmental drivers impact the surface area and heterogeneity of grassland patches in the landscape, which can lead to cascading effects for the grassland-dependent fauna.

Global Tiger Forum. (2022). Wild Tiger Conservation Across Tiger Range Countries: An Appraisal of Financial Shortfalls, 4th Asia Ministerial Conference (19-21 January, 2022), Kuala Lumpur, Malaysia.

SUMMARY

The status of wild tigers remains endangered, with their habitats undergoing rapid human-induced transformations, limiting their historical range to isolated “islands” amid diverse land uses. Effective tiger governance is crucial, categorized for both normal and conflict situations. To address challenges, understanding the required financial investment is essential. This study assesses financial gaps in tiger-protected areas across range countries.

The assessment provides an overview of tiger governance, major threats, and funding gaps concerning the Global Tiger Recovery Programme (GTRP). Using a “normative template,” fine-tuned for various forest types, data was gathered from Tiger Range Countries (TRCs), consultations, and GTRP portfolio reviews. Funding gap values are presented per 1000 sq. km. of tiger-protected area in a specific TRC.

The report outlines financing strategies to address identified gaps, from sovereign funds to multi-stakeholder contributions, proposing an innovative financial architecture for sustained resources. Tiger habitats are vital life support systems, necessitating integration into the global climate change agenda, economic growth considerations, and as a key indicator of human well-being.

Zhang, X., Liao, Y., Qin, T., Ma, J., Liu, J., Zou, J., Huang, H., Zhong, X., and Yang, M. (2022). Developmental stage variation in the gut microbiome of South China tigers. Frontiers in Microbiology, 13, 962614-. *http://dx.doi.org/10.3389/fmicb.2022.962614*.

ABSTRACT

South China tigers (Panthera tigris amoyensis , SC) are the most threatened tiger subspecies in the world. All the living SCs are captive in zoos or reserves and depend on artificial feeding. The composition of the gut microbiome plays an important role in sustaining the health of the host. A comprehensive understanding of the composition and development of the microbial community of SC is helpful to improve the feeding of captive SC. In this study, we collected 47 fecal samples, 37 of which were from SC of three developmental stages, 5 from adult Amur tigers (Am), and 5 from adult Bengal tigers (Bg), which were all housed in the same zoo. We investigated the diversity, richness, and composition of the bacterial microbiomes and we found that the gut microbiome of SC is strongly affected by host aging. The composition of the gut microbiome of juvenile SC experienced dramatic changes from 5 months old to 1 year old, and it showed much less difference when compared to the samples of 1 year old and the subadult. No significant differences were observed between the samples of subadult and the adult groups. The predominant phylum of 5-month-old SC is Fusobacteriota (33.99%) when the juvenile tigers were older than 5 months, and Firmicutes , but not Fusobacteriota , became the predominant phylum of bacteria in their gut. The gut microbiome of SC, Am, and Bg is possibly affected by their genetic variation; however, the core microbiome of these three subspecies is the same. Our data suggest that the gut microbiome of SC undergoes a developmental progression: a developmental phase (cub), a transitional phase (subadult), and a stable phase (adult). These results expand our understanding of the role of age in the development of the gut microbiome of SC.

Nirmalya Chakraborty

Manoj Dholakia

ASIA

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Zhilin Li; Jiayu Lu; Xiaoyi Shi; Li'an Duo; James L D Smith; Tianming Wang. (2023). Competitive interactions and coexistence of sympatric flagship carnivores in Asia. Integrative Zoology 00, 1–17. *https://doi.org/10.1111/1749-4877.12724*.

ABSTRACT

Understanding the competition and coexistence of flagship carnivores is key to creating strategies for their conservation in the face of global carnivore declines. Although studies exploring the dynamics and competition between tigers (Panthera tigris) and leopards (P. pardus) span decades, there is a lack of understanding regarding the factors that influence their coexistence mechanisms on a broad scale, as well as the drivers determining their exploitative and interference competition. We gathered a comprehensive list of research papers among which 36 papers explored the interspecific interactions between tigers and leopards and tested the influence of biotic and abiotic factors on the coexistence mechanisms along three dimensions using multiple response variables regression models; we also tested the influence of ecological drivers determining the exploitative or interference competition between tigers and leopards. Elevation and ungulate density were the most important predictors in regulating the coexistence mechanisms. Tigers and leopards exhibited more positive relations/higher overlaps as elevation increased in the spatial niche. In addition, they showed a higher dietary overlap in the prey-rich regions. We determined that interference competition between tigers and leopards was less frequently observed in habitats with dense tree cover and homogeneous vegetation structures. Meanwhile, studies with multiple metrics would promote the detection of interference competition. Our study provides new insight into the competitive interactions and coexistence mechanisms of tigers and leopards on a broad scale. Policy-makers and managers should pay more attention to the factors of elevation, prey abundance, and habitat structures for the conservation of tigers and leopards.

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATIONS

Gray, T. N. E., Chapman, S., Izquierdo, P., Jiang, G., Jin, Y., Kesaro, L., Lyet, A., Myo Shwe, N., Pasha, M. K. S., Patterson, D. J., Phan, C., Qi, J., Roberts, J. L., Rosenbaum, R., Roy, S., and Wolf, C. (2023). Restoring Asia's roar: Opportunities for tiger recovery across the historic range. Frontiers in Conservation Science, 4. *https://doi.org/10.3389/fcosc.2023.1124340*

ABSTRACT

Wildlife conservation in the Anthropocene requires bold conservation solutions including restoration of ecosystems and species. The recovery of large carnivore populations is a conservation goal which can generate significant benefits in terms of ecosystem services, ecological functionality, and human well-being. Tigers Panthera tigris , Asia's most iconic species, are currently restricted to less than 10% of their historic range with recent national extinctions from a number of countries in mainland Southeast Asia. Tiger recovery through range expansion requires suitable habitat, a robust prey base, and high levels of institutional support for conservation. We explored government support for conservation to produce a ranking of the political opportunities for tiger restoration across current and former tiger range countries. We used this analysis, in combination with globally remotely sensed data-sets on human impact, to show that there is potential for significant tiger range expansion. We identified large expanses of currently unoccupied, but potentially suitable, habitat in at least 14 countries including all extant tiger range countries and four countries with extirpated tiger populations – Cambodia, Lao PDR, Viet Nam, and Kazakhstan. Thirty-two percent of expansion areas were within 50-km, and 50% within 100-km, of current tiger populations highlighting that in many landscapes range expansion could be driven by the natural dispersal of tigers provided connectivity is maintained or enhanced. The proportion of potential range within existing protected areas varied between <5% in India, Indonesia, and China, to >60% in Thailand and Cambodia. As such socially appropriate conservation approaches, in collaboration with local communities, will be necessary to support tiger recovery in many areas. We recommend that some of the areas which we have identified should be highlighted as significant for future tiger conservation by tiger range country governments. Whilst the landscapes and sites which we identify will require detailed ground-truthing, and all tiger reintroductions need extensive planning and feasibility assessments, safeguarding these areas for human-carnivore coexistence could provide significant planetary benefits and support both tiger recovery and Global Sustainable Development Goals.

ZOOLOGY AND ANIMAL WELFARE

Wang, D., Smith, J. L. D., Accatino, F., Ge, J., and Wang, T. (2023). Addressing the impact of canine distemper spreading on an isolated tiger population in northeast Asia. 18(6), 994-1008. Integrative Zoology. *https://doi.org/10.1111/1749-4877.12712*

ABSTRACT

The continuation of the isolated Amur tiger (Panthera tigris altaica) population living along the China-Russia border is facing serious challenges due to factors such as its small size (including 38 individuals) and canine distemper virus (CDV). We use a population viability analysis metamodel, which consists of a traditional individual-based demographic model linked to an epidemiological model, to assess options for controlling the impact of negative factors through domestic dog management in protected areas, increasing connectivity to the neighboring large population (including more than 400 individuals), and habitat expansion. Without intervention, under inbreeding depression of 3.14, 6.29, and 12.26 lethal equivalents, our metamodel predicted the extinction within 100 years is 64.4%, 90.6%, and 99.8%, respectively. In addition, the simulation results showed that dog management or habitat expansion independently will not ensure tiger population viability for the next 100 years, and connectivity to the neighboring population would only keep the population size from rapidly declining. However, when the above three conservation scenarios are combined, even at the highest level of 12.26 lethal equivalents inbreeding depression, population size will not decline and the probability of extinction will be <5.8%. Our findings highlight that protecting the Amur tiger necessitates a multifaceted synergistic effort. Our key management recommendations for this population underline the importance of reducing CDV threats and expanding tiger occupancy to its former range in China, but re-establishing habitat connectivity to the neighboring population is an important long-term objective.

Hemant Singh

BANGLADESH

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATIONS

Mannan, I. A., Sujauddin, M., and Sohel, M. S. I. (2023). Evaluating the Financial Effectiveness of Funded Projects on Tiger Conservation in Bangladesh. Tropical Conservation Science, 16(1). DOI: 10.1177/19400829231188648.

ABSTRACT

The conservation of Bengal tigers is a global concern due to their exponential decline in population around the world. In 2010, all Tiger Range Countries (TRCs) committed to double their tiger population by 2022. As a member of the TRCs, Bangladesh has launched and conducted many tiger conservation projects with a heavy financial investment. However, the tiger population has not increased in the country. Therefore, there is an urgent need to investigate why those funded projects' outcomes were unsatisfactory compared to neighboring countries such as India and Nepal. Methods: This review was conducted purely based on previous archival tiger conservation related documents. Six specific tiger conservation projects implemented in Bangladesh, India, and Nepal were selected to investigate the effectiveness of tiger conservation in Bangladesh. Allocated fund distributions were segmented into five groups: capacity building, planning policy and reports, infrastructural development, tiger–human conflict (THC) reduction, and in-field actions to increase the tiger population. Results: The analysis showed that India and Nepal spent most of their budget on in-field activities and least on planning. A moderate amount was spent on THC reduction, capacity building, and infrastructural development. In contrast, Bangladesh spent the majority of its fund on planning. India and Nepal also developed a sustainable funding mechanism to reduce their dependency on donor agencies, which was absent in the case of Bangladesh. Conclusion: It is recommended that future tiger conservation initiatives in Bangladesh should address more in-field action, such as patrolling to stop poaching and the illegal extraction of resources, sustainable long-term alternative income generation activities, and health issues such as identifying diseases, inbreeding effects, and captive breeding. Implications for Conservation Bangladesh needs to develop a sustainable long-term funding mechanism for in-field actions for tiger protection.

Illegal Trade

Uddin, N., Enoch, S., Harihar, A., Pickles, R. S. A., and Hughes, A. C. (2023). Tigers at a crossroads: Shedding light on the role of Bangladesh in the illegal trade of this iconic big cat. Conservation Science and Practice, 5, e12952.

ABSTRACT

Unsustainable wildlife trade is a major threat to many species, but quantifying trade remains challenging, as seizure data provides an incomplete understanding. For this reason, integrating multiple types of information, including interviews with actors involved in trade, is crucial if we are to understand the problem better. Hence, in this study, we digitized Bangladesh Forest Department tiger seizure records to identify trade routes and interviewed 163 individuals involved in trafficking tigers through Bangladesh's air, sea and land ports, including poachers, smugglers, and traders. We identified six ports used to import tigers, 14 ports used for tiger export and three ports showing bi-directional trade. Elite Bangladeshis were the most important consumer group, and tigers were sourced from populations in NE India, Myanmar and Bangladesh Sundarbans to supply domestic demand. Tiger products were exported to 14 countries, including seven G20 nations, with Bangladeshi expatriates as the consumer group in three countries (United Kingdom, Germany and Qatar). Rising economic development in Bangladesh over the last decade, combined with deep-rooted cultural ties to tiger consumption, has led to a rise in domestic demand. Additionally, rapid growth in international transport links has increased smuggling and connected local traders with global markets, increasing the complexity of global trade. These findings suggest Bangladesh is poised to play a pivotal role in tiger conservation over the next decade, requiring strong national strategies to reduce trade opportunities, disrupt networks and weaken demand.

Dhritiman Mukherjee

BHUTAN

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Dendup, P., Lham, C., Wangchuk, W., and Jamtsho, Y. (2023). Tiger abundance and ecology in Jigme Dorji National Park, Bhutan. Global Ecology and Conservation, 42, e02378. *https://doi.org/10.1016/j.gecco.2023.e02378*.

ABSTRACT

Conservation of large carnivores, especially, wild tigers (Panthera tigris) require an accurate population estimate and knowledge of their ecology. Camera traps have been widely used to estimate the population abundance of animals with unique natural markings, cryptic behaviour, and low population density. This study aimed to assess tiger abundance and density, home range, and activity pattern in Jigme Dorji National Park (JDNP), Bhutan. We carried out camera traps from October 2021 to January 2022. A total of 56 camera stations (a pair in each station) was installed in a 5 × 5 km^2 grid along the latitudinal gradient of 1200–4300 m. With the sampling effort of 1528 trap nights, 478 tiger images were captured in 12 stations (21.4 % of the camera stations). Their unique stripe patterns identified six tigers (4 male and 2 female). We estimated tiger abundance of 15.16 ± SE 5.41 (9.13–32.79) and a density of 0.263 ± SE 0.115 (0.116–0.601 individuals) per 100 km^2. The home range analysis at 50 % kernel density estimators indicated 151 km^2 and 90 km^2 as the home range for the male and the female tiger, respectively. The activity pattern of the tigers in JDNP indicated crepuscular type with peak activity in 17:00–18:00 h. The tiger activity pattern strongly overlaps with the activity pattern of the Himalayan serow (Capricornis thar). The current study ascertains JDNP as an important tiger conservation area and can be a source for tiger population for other protected areas and Territorial Divisions. We recommend timely monitoring of tiger and their prey base population, and habitat through enhanced Spatial Monitoring and Reporting Tool (SMART) patrolling programs.

MONITORING AND ASSESSMENT

Dendup, P., and Lham, C. (2023). Photographic evidence suggests habitat overlap and co-occurrence of tigers and snow leopards in Jigme Dorji National Park, Bhutan. Oryx, 1-4. *https://doi.org/10.1017/S0030605323000078*.

ABSTRACT

The Endangered tiger Panthera tigris and Vulnerable snow leopard Panthera uncia are umbrella species and conservation priorities. Jigme Dorji National Park is an important protected area for the conservation of both species because it serves as a source site for tigers to adjacent areas and has the largest snow leopard population in Bhutan. Habitat overlap of tigers and snow leopards in Bhutan has been previously reported based on evidence of tigers (pugmarks, livestock killed and camera-trap images) in known snow leopard habitat above 4,000 m altitude. Here we report the first photographic evidence of both tigers and snow leopards at the same locations, confirming habitat overlap and co-occurrence of the two species. The data are derived from the countrywide tiger survey carried out during October 2021–January 2022. Fifty-six pairs of camera traps were installed in a 5 × 5 km grid at an altitude range of 1,200–4,300 m. After a survey effort of 1,528 trap-nights, 478 tiger images and 31 snow leopard images were captured at 12 and three camera stations, respectively. At all three camera stations that captured snow leopard images, tigers were also captured. These findings indicate the habitat overlap and co-occurrence of tigers and snow leopards in Jigme Dorji National Park. Further research is required to inform conservation practice in the National Park focusing on these apex predators.

Dhendup, T., Sharma, S., Painter, S., Whiteley, A. R., & Mills, L. S. (2023). Evidence of tiger population structure and dispersal in the montane conservation landscape of Bhutan. Global Ecology and Conservation, 43, e02459. *https://doi.org/10.1016/j.gecco.2023.e02459*

ABSTRACT

Bhutan is a part of the second-largest Tiger Conservation Landscape (TCL), The Northern Forest Complex-Namdapha-Royal Manas, and is home to a tiger population of global conservation priority. With its well-connected protected area network and a vast expanse of forested landscape, Bhutan has a unique potential to spatially connect tiger populations in the Terai TCL of India and Nepal on the western side to the north-eastern part of the Indian subcontinent. However, information on genetic structure and connectivity among tiger populations is lacking in the Eastern Himalayan region. Due to the large and contiguous forested landscape with a network of well-connected protected areas and strong environmental protection measures in Bhutan, tiger populations in Bhutan are expected to have high genetic variation and gene flow. We made the first-ever attempt at the genetic sampling of the tiger population in Bhutan, where we genotyped 24 tiger individuals using thirteen microsatellite loci. Genetic analyses revealed three genetic clusters and found high expected heterozygosity (mean HE = 0.73) and moderate-to-high genetic differentiation (FST = 0.135) within this pool of sampled tigers. We also were able to assign poached tigers to our inferred genetic clusters. Two individual wild tigers showed distinct multilocus genotypes, similar to each other but highly divergent from all other sampled tigers, suggesting their origin from outside the sampled areas. Our study provides the first insights into the population genetic structure of tigers in this important region

and suggests that gene flow is less than suggested by dispersal. A larger landscape-level genetic study with implications for the transboundary conservation of tigers in this highly biodiverse landscape is warranted.

Thapa, K., Thapa, G. J., Manandhar, U., Dhakal, M., Jnawali, S. R., and Maraseni, T. N. (2023). Carbonated tiger-high above-ground biomass carbon stock in protected areas and corridors and its observed negative relationship with tiger population density and occupancy in the Terai Arc Landscape, Nepal. PloS One, 18(1), e0280824. *https://doi.org/10.1371/journal.pone.0280824*.

ABSTRACT

Healthy natural forests maintain and/or enhances carbon stock while also providing potential habitat and an array of services to wildlife including large carnivores such as the tiger. This study is the first of its kind in assessing relationships between above-ground biomass carbon stock, tiger density and occupancy probability and its status in protected areas, corridors, and forest connectivity blocks. The dataset used to assess the relationship were: (1) Converged posterior tiger density estimates from camera trap data derived from Bayesian- Spatially Explicit Capture-Recapture model from Chitwan National Park; (2) Site wise probability of tiger occupancy estimated across the Terai Arc Landscape and (3) Habitat wise above-ground biomass carbon stock estimated across the Terai Arc Landscape. Carbon stock maps were derived based on eight habitat classes and conservation units linking satellite (Landsat 7 ETM+) images and field collected sampling data. A significant negative relationship ($r = -0.20$, $p<0.01$) was observed between above-ground biomass carbon stock and tiger density in Chitwan National Park and with tiger occupancy ($r = -0.24$, $p = 0.023$) in the landscape. Within protected areas, we found highest mean above-ground biomass carbon stock in high density mixed forest (~223 tC/ha) and low in degraded scrubland (~73.2 tC/ha). Similarly, we found: (1) highest tiger density ~ 0.06 individuals per 0.33 km^2 in the riverine forest and lowest estimates (~0.00) in degraded scrubland; and (2) predictive tiger density of 0.0135 individuals per 0.33 km^2 is equivalent to mean total of 43.7 tC/ha in Chitwan National Park. Comparatively, we found similar above-ground biomass carbon stock among corridors, large forest connectivity blocks (~117 tC/ha), and within in tiger bearing protected areas (~119 tC/ha). Carbon conservation through forest restoration particularly in riverine habitats (forest and grassland) and low transitional state forests (degraded scrubland) provides immense opportunities to generate win-win solutions, sequester more carbon and maintain habitat integrity for tigers and other large predators.

CHINA

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATIONS

Yang, B., Dai, Q., Xu, Y., Buesching, C. D., Gu, X., Yang, Z., Zhang, Z., and Wei, F. (2023). Need of a paradigm shift to conserve endangered species in China's national park system. Innovation, 4(4), 100462.

ABSTRACT

The article discusses the need for a paradigm shift in China's national park system to conserve endangered species. The authors propose performing a SLOSS analysis for the major existing national parks (NPs) in China and evaluating three possible management methods. Existing NPs in China have not yet been developed to include several local populations, which hampers the conservation of species like the giant panda and Amur tiger. Managing local populations according to a single set of criteria may prove suboptimal, as dispersed populations can exhibit genetic, morphological, behavioral, and life history differences. The article emphasizes the importance of fully understanding the population structure and dynamics of protected species to develop effective conservation strategies and management measures. The authors argue for a paradigm shift in China's protected area system, with national parks as the focus, to integrate landscape-scale conservation and address the specific conditions and requirements of local population conservation.

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Movement Ecology

Wang, Y., Cheng, W., Guan, Y., Qi, J., Roberts, N. J., Wen, D. et al. (2023) The fine-scale movement pattern of Amur tiger (Panthera tigris altaica) responds to winter habitat permeability. Wildlife Letters, 1, 119–130. *https://doi.org/10.1002/wll2.12020*.

ABSTRACT

The number of Amur tigers living in protected regions is increasing, and China has achieved significant progress in this regard, especially at the Sino-Russia border region around Hunchun where most of the Amur tigers are found in China. However, there is a need to increase the dispersal of Amur tigers further from the border as the region is not large enough to support the sustainable survival of the population. In the winter of 2012–2015 and January 2022, we tracked 38 Amur tiger snow traces and performed line transect and camera trap surveys in

Hunchun to assess Amur tiger movements in response to the landscape and its permeability at fine scales. Our results showed that towns, shrubs, and forest roads are the main factors influencing Amur tiger movements. Furthermore, tiger paths were characterized by lower tortuosity in preferred habitats. This provides information for small-scale habitat modification to increase landscape permeability and facilitate dispersal.

GENETICS

Lan, T., Li, H., Zhang, L., Shi, M., Liu, B., Cui, L., Dussex, N., Wang, Q., Ma, Y., Liu, D., Kong, W., Wang, J., Lu, H., Zhang, S., Yu, J., Wang, X., Wu, Y., Niu, X., Fan, J., Zhao, Y., Dalén, L., Jiang, G., Liu, H., and Xu, Y. (2023). Population genomics reveals extensive inbreeding and purging of mutational load in wild Amur tigers.

ABSTRACT

The inbreeding is a big threat for the persistence of genetic diversity in small and isolated populations of endangered species. The homozygous genome could exacerbate inbreeding depression by introducing homozygous deleterious alleles in the population. However, purging of inbreeding loads as they become homozygotes in small populations could alleviate the depression. The Amur tiger (Panthera tigris altaica) is typically exists in small population living in forests in Northeast Asia and is among the most endangered animals on the planet with great symbolic significance of conservation. By comparing with captive individuals, we revealed substantially higher and more extensive inbreeding in the wild Amur tiger population (FROH=0.51) than in captive Amur tigers (FROH=0.26). We further found much less mutational loads in wild populations when compared with captive Amur tigers. However, the frequency of loss of function and deleterious nonsynonymous mutations inside ROH regions are much lower than that in non-ROH regions in both wild and captive Amur tigers, indicating the purging may had occurred in both populations but much effective in the wild population. In addition, we found the average frequency of deleterious alleles was much lower than that of neutral alleles in the wild population, indicating that the purifying selection contributed to the purging of mutational loads in the wild Amur tigers. These findings provide valuable genome-wide evidence to support the making of future conservation plans of wild Amur tigers.

Sun, X., Liu, YC., Tiunov, M.P. et al. (2023). Ancient DNA reveals genetic admixture in China during tiger evolution. Nat Ecol Evol 7, 1914–1929.
https://doi.org/10.1038/s41559-023-02185-8.

ABSTRACT

The tiger (Panthera tigris) is a charismatic megafauna species that originated and diversified in Asia and probably experienced population contraction and expansion during the Pleistocene, resulting in low genetic diversity of modern tigers. However, little is known about patterns of genomic diversity in ancient populations. Here we generated whole-genome sequences from ancient or historical (100–10,000 yr old) specimens collected across mainland Asia, including a 10,600-yr-old Russian Far East specimen (RUSA21, 8× coverage) plus six ancient mitogenomes, 14 South China tigers (0.1–12×) and three Caspian tigers (4–8×). Admixture analysis showed that RUSA21 clustered within modern Northeast Asian phylogroups and partially derived from an extinct Late Pleistocene lineage. While some of the 8,000–10,000-yr-old Russian Far East mitogenomes are basal to all tigers, one 2,000-yr-old specimen resembles present Amur tigers. Phylogenomic analyses suggested that the Caspian tiger probably dispersed from an ancestral Northeast Asian population and experienced gene flow from southern Bengal tigers. Lastly, genome-wide monophyly supported the South China tiger as a distinct subspecies, albeit with mitochondrial paraphyly, hence resolving its longstanding taxonomic controversy. The distribution of mitochondrial haplogroups corroborated by biogeographical modelling suggested that Southwest China was a Late Pleistocene refugium for a relic basal lineage. As suitable habitat returned, admixture between divergent lineages of South China tigers took place in Eastern China, promoting the evolution of other northern subspecies. Altogether, our analysis of ancient genomes sheds light on the evolutionary history of tigers and supports the existence of nine modern subspecies.

Wang, C., Wu, D.-D., Yuan, Y.-H., Yao, M.-C., Han, J.-L., Wu, Y.-J., Shan, F., Li, W.-P., Zhai, J.-Q., Huang, M., Peng, S.-M., Cai, Q.-H., Yu, J.-Y., Liu, Q.-X., Liu, Z.-Y., Li, L.-X., Teng, M.-S., Huang, W., Zhou, J.-Y., Zhang, C., Chen, W., and Tu, X.-L. (2023). Population genomic analysis provides evidence of the past success and future potential of South China tiger captive conservation. BMC Biology, 21(1), 64.

ABSTRACT

Background: Among six extant tiger subspecies, the South China tiger (Panthera tigris amoyensis) once was widely distributed but is now the rarest one and extinct in the wild. All living South China tigers are descendants of only two male and four female wild-caught tigers and they survive solely in zoos after 60 years of effective conservation efforts. Inbreeding depression and hybridization with other tiger subspecies were believed to have occurred within the small, captive South China tiger population. It is therefore urgently needed to examine the genomic landscape of existing genetic variation among the South China tigers.

Results: In this study, we assembled a high-quality chromosome-level genome using long-read sequences and re-sequenced 29 high-depth genomes of the South China tigers. By combining and comparing our data with the other 40 genomes of six tiger subspecies, we identified two significantly differentiated genomic lineages among the South China tigers, which harbored some rare genetic variants introgressed from other tiger subspecies and thus maintained a moderate genetic diversity. We noticed that the South China tiger had higher FROH values for longer runs of homozygosity (ROH > 1 Mb), an indication of recent inbreeding/founder events. We also observed that the South China tiger had the least frequent homozygous genotypes of both high- and moderate-impact deleterious mutations, and lower mutation loads than both Amur and Sumatran tigers. Altogether, our analyses indicated an effective genetic purging of deleterious mutations in homozygous states from the South China tiger, following its population contraction with a controlled increase in inbreeding based on its pedigree records.

Conclusions: The identification of two unique founder/genomic lineages coupled with active genetic purging of deleterious mutations in homozygous states and the genomic resources generated in our study pave the way for a genomics-informed conservation, following the real-time monitoring and rational exchange of reproductive South China tigers among zoos.

MOITORING AND ASSESSMENT

Alibhai, S. K., Gu, J., Jewell, Z. C., Morgan, J., Liu, D., and Jiang, G. (2023). 'I know the tiger by his paw': A non-invasive footprint identification technique for monitoring individual Amur tigers (Panthera tigris altaica) in snow. Ecological Informatics, 73, 101947. *https://doi.org/10.1016/j.ecoinf.2022.101947*.

ABSTRACT

Apex predator populations are in decline around the world. Many exist at low density and are elusive, making the acquisition of reliable data on their numbers and distribution a considerable challenge. The Amur tiger (Panthera tigris altaica) is the largest of the five extant sub-species of tiger. The single most significant, contiguous population, an estimated 550 animals, exists in the Russian Far East, with smaller populations on the far eastern Sino-Russian border. For the last few decades, active efforts on the part of Chinese authorities have encouraged the recolonization of these populations back to their former ranges in Northeast China. Reliable data on Amur tiger numbers and distribution are required to assess population recovery at the landscape scale. Footprints, ubiquitous in the snow over range areas, could inform on these baseline data. This paper describes a statistically robust, cost-effective and non-invasive footprint identification technique (FIT) to identify individual tigers from footprints in snow. It is based on a rigorous data collection and data-processing protocol, combined with a cross-validated discriminant analysis method. A Ward's clustering technique provides a visual output of individual classification. The analytical tools are packaged in a user-friendly analytical interface. Between December 2011 and December 2012, we collected a series of 605 footprint images from 44 captive individual Amur tigers for a reference database from which to derive a classification algorithm. The 23 females and 21 males ranged in age from 3 to 13 years (female mean age 7.95 +/− 0.18; male mean age 8.08 +/− 0.19). 128 measurements (areas, lengths and angles) were taken from each print and analyzed with the FIT add-in to JMP software. The derived classification algorithm was then applied to 21 footprint trails collected from an unknown number of free-ranging Amur tigers during 2012 and 2015/2016. The algorithm predicted 7 Amur tigers at the site surveyed in 2012, and 4 tigers surveyed at two sites in 2015/16. We demonstrate that the footprint identification technique translates traditional tracking methodologies into a statistically robust and objective analytical tool that can be deployed by both scientists and local communities to monitor the recovery of big cat populations.

Liu, B., and Qu, Z. (2023). AF-TigerNet: A lightweight anchor-free network for real-time Amur tiger (Panthera tigris altaica) detection. Wildlife Letters, 1(1), 32-41.

ABSTRACT

Monitoring the critically endangered Amur tiger (Panthera tigris altaica) is crucial for the conservation of the natural environment. This paper proposes a novel lightweight deep-learning network for detecting Amur tigers in mobile and resource-constrained environments, like those using unmanned aerial vehicles. The network uses an anchor-free mechanism with modified CSPNet and cross stage partial (CSP)-path aggregation network (PAN) structures, which improves the model's feature extraction capabilities. Label assignment strategy is also improved to stabilize the model training process. Additionally, the random Mosaic and Mixup data augmentation strategy is utilized to address the overfitting issue due to insufficient data in the data set. The model achieves 55.5% mean average precision (mAP [0.5:0.95]) with only 0.617 million parameters and 73.58 frames per second on mobile CPU with 416*416 pixels input. Results show that the model is an accurate, fast, and practical detector of the Amur tiger, serving as a reference for wildlife detectors of other species.

GLOBAL

HUMAN-WILDLIFE INTERACTION AND CONFLICT MITIGATION

Braczkowski, A. R., O'Bryan, C. J., Lessmann, C., Rondinini, C., Crysell, A. P., Gilbert, S., Stringer, M., Gibson, L., and Biggs, D. (2023). The unequal burden of human-wildlife conflict. Communications Biology, 6(1), 182.

Human-wildlife conflict is one of the most pressing sustainable development challenges globally. This is particularly the case where ecologically and economically important wildlife impact the livelihoods of humans. Large carnivores are one such group and their co-occurrence with low-income rural communities often results in real or perceived livestock losses that place increased costs on already impoverished households. Here we show the disparities associated with the vulnerability to conflict arising from large carnivores on cattle (Bos taurus) globally. Across the distribution of 18 large carnivores, we find that the economic vulnerability to predation losses (as measured by impacts to annual per capita income) is between two and eight times higher for households in transitioning and developing economies when compared to developed ones. This potential burden is exacerbated further in developing economies because cattle keepers in these areas produce on average 31% less cattle meat per animal than in developed economies. In the lowest-income areas, our estimates suggest that the loss of a single cow or bull equates to nearly a year and a half of lost calories consumed by a child. Finally, our results show that 82% of carnivore range falls outside protected areas, and five threatened carnivores have over one third of their range located in the most economically sensitive conflict areas. This unequal burden of human-carnivore conflict sheds light on the importance of grappling with multiple and conflicting sustainable development goals: protecting life on land and eliminating poverty and hunger.

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATIONS

Climate Change

Lamba, A., Teo, H. C., Sreekar, R., Zeng, Y., Carrasco, L. R., and Koh, L. P. (2023). Climate co-benefits of tiger conservation. Nature Ecology and Evolution, 7(7), 1104-1113.

ABSTRACT

Biodiversity conservation is increasingly being recognized as an important co-benefit in climate change mitigation programmes that use nature-based climate solutions. However, the climate co-benefits of biodiversity conservation interventions, such as habitat protection and restoration, remain understudied. Here we estimate the forest carbon storage co-benefits of a national policy intervention for tiger (Panthera tigris) conservation in India. We used a synthetic control approach to model avoided forest loss and associated carbon emissions reductions in protected areas that underwent enhanced protection for tiger conservation. Over a third of the analysed reserves showed significant but mixed effects, where 24% of all reserves successfully reduced the rate of deforestation and the remaining 9% reported higher-than-expected forest loss. The policy had a net positive benefit with over 5,802 hectares of averted forest loss, corresponding to avoided emissions of 1.08 ± 0.51 MtCO2 equivalent between 2007 and 2020. This translated to US$92.55 ± 43.56 million in ecosystem services from the avoided social cost of emissions and potential revenue of US$6.24 ± 2.94 million in carbon offsets. Our findings offer an approach to quantitatively track the carbon sequestration co-benefits of a species conservation strategy and thus help align the objectives of climate action and biodiversity conservation.

BIOLOGY, ECOLOGY, AND NATURAL HISTORY

Ecology

Can andE and D'Cruze N (2023) Cognitive biases can play a role in extinction assessments: The case of the Caspian tiger. Front. Ecol. Evol. 10:1050191. doi: 10.3389/fevo.2022.1050191.

ABSTRACT

The premature declaration of a species as extinct has been reported across different taxonomic groups and is commonly referred to as Romeo's error or the Lazarus effect. In this study, based on a review of historical records and testimonies from local communities, we review the case of Caspian tiger (Panthera tigris virgata), a species we consider was prematurely declared globally extinct in 1950s. Considering that compelling evidence which suggests that Caspian tigers existed in Turkey perhaps up until early 1990s (some 40 years after international scientific community considered the species extinct) it is reasonable to posit that conservationists missed a historical opportunity to save the species. The case of the Caspian tiger demonstrates the cognitive bias of the Dunning-Kruger effect in action and the potential implications for conservation experts who are engaged in remotely evaluating contemporary species distributions. To mitigate these factors when assessing the global status of species threatened by extinction, we suggest that increased awareness of this type of cognitive bias could facilitate the introduction of additional measures in relevant conservation initiatives and in IUCN Red List assessments. For example, the formation of independent and specific teams to unearth implicit assumptions and weaknesses in assessments, and to question the group thinking of the species assessors. Against the backdrop of the current unprecedented rapid

biodiversity decline, we recommend that researchers should be alert of the cognitive biases involved in species assessments and in conservation at large.

Srivathsa, A., Ramachandran, V., Saravanan, P., Sureshbabu, A., Ganguly, D. and Ramakrishnan, U. (2023), Topcats and underdogs: intraguild interactions among three apex carnivores across Asia's forestscapes. Biol Rev, 98: 2114-2135. *https://doi.org/10.1111/brv.12998*

ABSTRACT

Intraguild interactions among carnivores have long held the fascination of ecologists. Ranging from competition to facilitation and coexistence, these interactions and their complex interplay influence everything from species persistence to ecosystem functioning. Yet, the patterns and pathways of such interactions are far from understood in tropical forest systems, particularly across countries in the Global South. Here, we examined the determinants and consequences of competitive interactions between dholes Cuon alpinus and the two large felids (leopards Panthera pardus and tigers Panthera tigris) with which they most commonly co-occur across Asia. Using a combination of traditional and novel data sources (N = 118), we integrate information from spatial, temporal, and dietary niche dimensions. These three species have faced catastrophic declines in their extent of co-occurrence over the past century; most of their source populations are now confined to Protected Areas. Analysis of dyadic interactions between species pairs showed a clear social hierarchy. Tigers were dominant over dholes, although pack strength in dholes helped ameliorate some of these effects; leopards were subordinate to dholes. Population-level spatio-temporal interactions assessed at 25 locations across Asia did not show a clear pattern of overlap or avoidance between species pairs. Diet-profile assessments indicated that wild ungulate biomass consumption by tigers was highest, while leopards consumed more primate and livestock prey as compared to their co-predators. In terms of prey offtake (ratio of wild prey biomass consumed to biomass available), the three species together harvested 0.4–30.2% of available prey, with the highest offtake recorded from the location where the carnivores reach very high densities. When re-examined in the context of prey availability and offtake, locations with low wild prey availability showed spatial avoidance and temporal overlap among the carnivore pairs, and locations with high wild prey availability showed spatial overlap and temporal segregation. Based on these observations, we make predictions for 40 Protected Areas in India where temporally synchronous estimates of predator and prey densities are available. We expect that low prey availability will lead to higher competition, and in extreme cases, to the complete exclusion of one or more species. In Protected Areas with high prey availability, we expect intraguild coexistence and conspecific competition among carnivores, with spill-over to forest-edge habitats and subsequent prey-switching to livestock. We stress that dhole–leopard–tiger co-occurrence across their range is facilitated through an intricate yet fragile balance between prey availability, and intraguild

and conspecific competition. Data gaps and limitations notwithstanding, our study shows how insights from fundamental ecology can be of immense utility for applied aspects like large predator conservation and management of human–carnivore interactions. Our findings also highlight potential avenues for future research on tropical carnivores that can broaden current understanding of intraguild competition in forest systems of Asia and beyond.

GENETICS

Henger, C. S., Straughan, D. J., Xu, C. C. Y., Nightingale, B. R., Kretser, H. E., Burnham-Curtis, M. K., McAloose, D., and Seimon, T. A. (2023). A new multiplex qPCR assay to detect and differentiate big cat species in the illegal wildlife trade. Scientific Reports, 13(1), 9796.

ABSTRACT

All species of big cats, including tigers, cheetahs, leopards, lions, snow leopards, and jaguars, are protected under the Convention on the International Trade in Endangered Species (CITES). This is due in large part to population declines resulting from anthropogenic factors, especially poaching and the unregulated and illegal trade in pelts, bones, teeth and other products that are derived from these iconic species. To enhance and scale up monitoring for big cat products in this trade, we created a rapid multiplex qPCR test that can identify and differentiate DNA from tiger (Panthera tigris), cheetah (Acinonyx jubatus), leopard (Panthera pardus), lion (Panthera leo), snow leopard (Panthera uncia), and jaguar (Panthera onca) in wildlife products using melt curve analysis to identify each species by its unique melt peak temperature. Our results showed high PCR efficiency (> 90%), sensitivity (detection limit of 5 copies of DNA per PCR reaction) and specificity (no cross amplification between each of the 6 big cat species). When paired with a rapid (< 1 h) DNA extraction protocol that amplifies DNA from bone, teeth, and preserved skin, total test time is less than three hours. This test can be used as a screening method to improve our understanding of the scale and scope of the illegal trade in big cats and aid in the enforcement of international regulations that govern the trade in wildlife and wildlife products, both ultimately benefiting the conservation of these species worldwide.

ZOOLOGY AND ANIMAL WELFARE

Armstrong, E. E., Mooney, J. A., Solari, K. A., Kim, B. Y., Barsh, G. S., Grant, V., ... Hadly, E. A. (2023). Unraveling the genomic diversity and evolutionary history of captive tigers in the United States.

ABSTRACT

Genetic and genomic studies of rare and endangered species have focused broadly on describing diversity patterns and resolving phylogenetic relationships, with the overarching goal of informing conservation efforts. However, many studies do not consider genetic reserves that are potentially housed in captive populations. For tigers (Panthera tigris) in particular, captive individuals vastly outnumber those in the wild, and their diversity remains largely unexplored. Here, we present the first large-scale genetic study of the private (non-zoo) captive tiger population in the United States (U.S.), also known as 'Generic' tigers. We find that the U.S. Generic tiger population has an admixture fingerprint comprising all six extant wild tiger subspecies (P. t. altaica , Amur; P. t. tigris , Bengal; P. t. corbetti , Indochinese; P. t. jacksoni , Malayan; P. t. amoyensis , South China; P. t. sumatrae , Sumatran). We show that the Generic tiger population has a comparable amount of genetic diversity to most wild subspecies, relatively few private variants, and fewer deleterious mutations. We also observe inbreeding coefficients that are similar to wild populations, suggesting that inbreeding in captive populations is not prevalent as previously thought, although there are some individuals within the Generic population that are quite inbred. Our results reflect the complex demographic history of the Generic tiger population in the U.S. Additionally, we develop a reference panel for tigers and show that it can be used with imputation to accurately distinguish individuals and assign ancestry even with ultra-low coverage (0.25×) data. We anticipate this comprehensive study and panel will propel future research and preservation of tigers in the U.S. and globally.

Bashawat, M., Braun, B. C., Müller, K., and Hermann, B. P. (2023). Molecular phenotyping of domestic cat (Felis catus) testicular cells across postnatal development - A model for wild felids. Theriogenology Wild, 2, 100031.

ABSTRACT

Molecular characterisation of testicular cells is a pivotal step towards a profound understanding of spermatogenesis and developing assisted reproductive techniques (ARTs) based on germline preservation. To enable the identification of testicular somatic and spermatogenic cell types in felids, we investigated the expression of five molecular markers at the protein level in testes from domestic cats (Felis catus) at different developmental phases (prepubertal, pubertal I and II, postpubertal I and II) classified by single-cell ploidy analysis. Our findings indicate a prominent co-labelling for two spermatogonial markers, UCHL1 and FOXO1, throughout postnatal testis development. Smaller subsets of UCHL1 or FOXO1 single-positive spermatogonia were also evident, with the FOXO1 single-positive spermatogonia predominantly observed in prepubertal testes. As expected, DDX4+ germ cells increased in numbers beginning in puberty, reaching a maximum at adulthood (post-pubertal phase), corresponding to the sequential appearance of labelled spermatogonia, spermatocytes and spermatids. Furthermore, we identified SOX9+ Sertoli cells and CYP17A1+ Leydig cells in all of the developmental groups. Importantly, testes of African lion (Panthera leo), Sumatran tiger (Panthera tigris sumatrae), Chinese leopard (Panthera pardus japonesis) and Sudan cheetah (Acinonyx jubatus soemmeringii) exhibited conserved labelling for UCHL1, FOXO1, DDX4, SOX9 and CYP17A1. The present study provides fundamental information about the identity of spermatogenic and somatic testicular cell types across felid development that will be useful for developing ART approaches to support endangered felid conservation.

Costa, T., Stidworthy, M. F., Ehmann, R., Denk, D., Ashpole, I., Drake, G., ... Chantrey, J. (2023). Cowpox in zoo and wild animals in the United Kingdom. Journal of Comparative Pathology, 204, 39-46.

ABSTRACT

Cowpox virus is considered to be a re-emerging zoonotic pathogen and a public health threat due to increasing numbers of cases in humans and animals in Europe over the past decade, including within the United Kingdom (UK). We present epidemiological data and diagnostic features of 27 recent, naturally occurring cowpox cases in zoo and wild animals across the UK, including the first reports of cowpox in two snow leopards (Panthera uncia), a Bengal tiger (Panthera tigris tigris), three Chilean pudus (Pudu puda), a Malayan tapir (Tapirus indicus) and a Eurasian otter (Lutra lutra), and the first reports of Orthopoxvirus infection in a lar gibbon (Hylobates lar), a Southern tamandua (Tamandua tetradactyla) and an aardvark (Orycteropus afer). This study provides a detailed overview of cowpox infections in a wide range of non-domestic animal species, presents a range of methods for diagnosis and demonstrates the value of retrospective analysis of pathology surveillance in revealing epidemiological links.

Dianis, A. E., Pinard, C. L., Pagliarani, S., Susta, L., and Dutton, C. J. (2023). Congenital glaucoma in a tiger (Panthera tigris). Veterinary Ophthalmology, 26(4), 355-360.

Objective: To describe a case of congenital glaucoma in atiger (Panthera tigris).

Animal Studied: An 8-month-old intact female tiger wasreferred for suspected glaucoma of the right eye. The right eye was buphthalmicwith moderate episcleral injection, circumferential superficial cornealneovascularization, moderate corneal edema, and a fixed dilated pupil. Tapetalreflection was absent due to a mature cataract. Rebound tonometry under generalanesthesia revealed 70 mmHg and 21 mmHg in the right and left eye, respectively.

Procedure: A trans-conjunctival enucleation was performedand the globe was submitted for

histopathology.

Results: Histopathology revealed a thin sclera, amorphousmaterial contouring an imperforate and hypoplastic iridocorneal angle, ahypoplastic lens with severe anterior-posterior compression, subcapsularepithelial hyperplasia, and Morganian globules, and segmental moderate retinalatrophy. Periodic acid-Schiff stain highlighted segmental dilations of theDescemet's membrane. Masson trichrome stain highlighted a pre-irido collagenmembrane.

Conclusion: The tiger's age and histopathologic findingsare consistent with congenital goniodysgenesis. This is the first known reportof congenital glaucoma in a tiger.

Formanová, D., Pyszko, M., Horak, O., Sadkova, J., Rihova, P., and Kubatova, A. (2023). Foramen ovale as a new determinative sign for the identification of tiger (Panthera tigris) and lion (Panthera leo) skulls.

ABSTRACT

Tiger and lion bones are valued highly on the wildlife black market. The skeletons of the two species are very similar, but the level of protection and the laws applicable to them differ. When detecting crime in the field, it can be crucial to recognize the skeletons of these two species by their morphological features. A distinguishing feature not yet described in the literature is the foramen ovale at the base of the skull. A total of 112 skulls were evaluated, 55 tigers and 57 lions. The orientation and appearance of the foramina ovalia were analysed on skull photographs. Significant differences were found between tigers and lions. In lions, the foramina ovalia faced laterally and their outlets were usually at least partially hidden behind the straight edge of the os basisphenoidale from the ventral view of the skull. Tiger skulls on the other hand exhibited higher variability in foramina ovalia orientation. In most adult tigers the foramina ovalia faced more rostrally and their outlets were bounded by a semi-circular edge of the os basisphenoidale . Like other identifying features on tiger and lion skulls, the foramen ovale was unable to distinguish all skulls with 100% confidence. Nevertheless, knowledge of this structure can help considerably in species identification.

Gilbert, M., Dvornicky-Raymond, Z., and Bodgener, J. (2023). Disease threats to tigers and their prey. Frontiers in Ecology and Evolution, 11(1135935-701X). doi:10.3389/fevo.2023.1135935.

ASBTRACT

The contraction of the global tiger population over the last 100 years into small, often isolated subpopulations has made them increasingly vulnerable to the impact of disease. Despite

this, the health of wild tigers continues to be insufficiently funded and explored. For example, canine distemper virus (CDV), has been associated with localized declines and increased risk of extinction, and yet has received little research attention in most tiger range countries. The emergence of new pathogenic threats has posed fresh challenges, including African swine fever virus (ASFV), which has the potential to devastate wild boar populations, and severe acute respiratory syndrome coronavirus (SARS-CoV2) with implications for tiger conservation that remain unknown. The objective of this review is to synthesize current research on the health of tigers and their prey that impacts the conservation of tigers in the wild. Published sources are interpreted based on three mechanisms through which disease can affect the viability of tiger populations: (1) by reducing the survival of adult tigers, (2) by reducing breeding productivity, and (3) by reducing the carrying capacity of tiger habitat through decreased prey abundance. Examples of CDV, SARS-CoV2, carnivore protoparvovirus 1 and ASFV are used to illustrate these processes and inform discussion of research and mitigation priorities.

Hilda Liliana Sánchez, N. M., Francisco Alarcón, M. E. Rafasquino, Juan José Diorio, Gustavo Zuccolilli, Enrique Leo Portiansky. (2023). Origin and distribution pattern of pelvic limb nerves of a Bengal tiger (Panthera tigris tigris). Anatomia, Histologia, Embryologia.

ABSTRACT

The Bengal tiger (Panthera tigris tigris) is a species belonging to the Felidae family. In Argentina, tigers are currently only found in captivity. The longevity of individual animals in human-controlled environments depends on proper management and practices that prioritize animal welfare. Regular veterinary care is essential to maintain optimal health conditions. Professionals must have a comprehensive understanding of the anatomy and physiology of tigers to effectively perform medical procedures and administer treatments. The study described in the text focuses on the trajectory and distribution of nerves in the pelvic limb of a Bengal tiger specimen, providing detailed dissection findings. The results revealed that the lumbosacral plexus is formed from the ventral rami of the LIV, LV, LVI, LVII, SI, SII and SIII nerves. Among the observations to highlight is the great development of the nerves N. cutaneus femoris lateralis and N. cutaneus femoris caudalis some differences were observed in the distribution of the N. femoralis and N. obturatorius; the N. ischiadicus, together with its division into the fibularis communis and tibialis nerves, showed the same configuration observed in other cats. Finally, it was observed that the nerves N. gluteus cranialis and N. gluteus caudalis also originated from the truncus lumbosacralis. The similarities and differences with studies carried out on other cats are relevant and provide anatomical data for medical procedures in the Bengal tiger.

Khan, M. A., Shabir, S., Azeem, S., Gill, W., Ashraf, K., Azhar, M., ... Akbar, H. (2023). Documentation of Trypanosoma evansi in captive tigers and lions in Punjab (2016-2018),

Pakistan. Journal of Zoo and Wildlife Medicine: Official Publication of the American Association of Zoo Veterinarians, 53(4), 823.

ABSTRACT

Trypanosoma evansi is an important hemoparasite of a variety of animal species worldwide. This parasite is a threat to the health of domestic animals as well as wild animals, particularly those managed in captivity. The current study investigated the presence of T. evansi in captive tigers (Panthera tigris tigris) and lions (Panthera leo) in Pakistan. In total, 24 blood samples from 11 tigers and 3 lions (n = 14) were collected during the course of roughly 3 yr (2016-2018). Eighteen samples were subjected to both microscopic and molecular evaluation for the presence of T. evansi; the remaining 6 samples were processed for PCR only. Of the 18 samples tested by both methods, 3 (16%) and 8 (44%) were positive by microscopy and PCR, respectively. This highlights the higher sensitivity of PCR over microscopy for detection of trypanosomes. Of the 24 total samples evaluated by PCR, 12 (50%) were positive. The three sequences obtained showed 99% identity with variant surface glycoprotein genes of the different isolates of T. evansi. The sensitivity, specificity, positive predictive value, and negative predictive value of microscopy in identifying T. evansi was 37.5, 100, 100, and 66.7%, respectively, considering PCR as the gold standard. We recommend rigorous monitoring of captive tigers and lions for hemoparasites, particularly in winter and early spring in areas with high infection rate of this parasite, preferably via PCR.

Kopp, E., Stelzer, P., Lendl, C., Meyer-Lindenberg, A., and Fahrenkrug, P. (2023). Evaluation of dental and oral pathologies of 36 captive lions (Panthera leo) and tigers (Panthera tigris). Journal of Veterinary Dentistry.

The documented increase in the occurrence of dental diseases in captive big cats over the past decades has necessitated the need to target dental medical research accordingly. The aim of this study was the systematic evaluation of dental and oral pathologies of lions and tigers which included intraoral dental radiography. Thirty-six animals of both sexes, ranging in age from nine months to 18 years, predominantly in circus husbandry, served as the basis of the present study, and their dental health status was investigated. The preliminary report and history, adspection of the awake animal, and examination under anesthesia provided important information. Eight animals were specifically presented for oral examination because of known dental disease. The remaining 28 animals were anesthetized for other medically necessary procedures, and each animal's oral and dental health status was also evaluated while under anesthesia. In the 28 animals that underwent routine oral cavity examination, pathological changes that had not previously been noticed were found in two-thirds of the animals (19/28). One-quarter of all the animals (9/36) had no abnormal oral cavity findings. Dentoalveolar trauma such as tooth fractures and abrasion (24/36) were diagnosed most frequently. The results highlight the importance of regular oral examinations in big cats. Furthermore, the results suggest that there is a relationship between husbandry conditions and the incidence of dentoalveolar trauma in captive big cats.

Khonmee, J., Brown, J. L., López Pérez, A., Lertwichaikul, T., Sathanawongs, A., Pornnimitra, P., ... Punturee, K. (2023). Effect of Electroejaculation Protocols on Semen Quality and Concentrations of Testosterone, Cortisol, Malondialdehyde, and Creatine Kinase in Captive Bengal Tigers. Animals, 13(12), 1893.

ABSTRACT

The Bengal tiger (Panthera tigris tigris) is critically endangered, so assisted reproductive technologies, including artificial insemination, are important conservation tools. For wild and domestic felids, electroejaculation (EE) is the most common semen collection method, with protocols optimized to obtain sufficient amounts of viable sperm for artificial insemination. However, less attention has been paid to ensuring animal wellbeing during the process. This study examined the effects of three EE protocols (Low, 2-5 volts; Medium, 3-6 volts; High, 4-7 volts) on semen quality, testicular size, serum testosterone, creatine kinase (CK), and malondialdehyde (MDA) concentrations, and serum cortisol as a proxy for stress. Blood samples were collected before, during, and after each EE series. Seminal plasma pH, and sperm motility, viability, and morphology were evaluated after each procedure. Seminal plasma and sperm pellet MDA concentrations were also determined. Primary sperm abnormalities and seminal plasma MDA were higher in the Low compared to Medium and High voltage groups ($p < 0.05$). Serum CK in the High voltage group increased during the EE series ($p < 0.05$), suggesting the potential for muscle damage. However, no significant changes were observed for serum cortisol, testosterone, or MDA concentrations. Results suggest the Medium voltage protocol produced good quality samples at lower voltages than the High protocol with no negative effect on muscle function, which might be better for animal welfare.

Niedringhaus, K. D., Gordon, M., Yabsley, M. J., Gai, J., Uzal, F. A., and Woolard, K. D. (2023). Fatal balamuthosis in a Siberian tiger and a literature review of detection options for free-living amoebic infections in animals. Journal of Veterinary Diagnostic Investigation, 35(3), 311-316.

ABSTRACT

Free-living amoebae are rare causes of morbidity and mortality in humans and animals around the globe. Because the route of exposure and clinical progression of disease caused by different species of amoebae may vary in people and animals, determining the species of

amoeba present is important. We describe here a fatal infection by the free-living amoeba Balamuthia mandrillaris in a Siberian tiger (Panthera tigris altaica). The 17-y-old patient had a rapid clinical decline after a peracute onset of severe lethargy, dull mentation, and anorexia. Autopsy did not identify a cause of death. Histology revealed inflammation associated with amoebic trophozoites in the brain, lungs, and iris of one eye. These amoebae were confirmed to be B. mandrillaris based on a PCR assay and sequencing. Although there are subtle morphologic differences between cyst stages of Acanthamoeba spp., B. mandrillaris, and Naegleria fowleri when present and identified on routine staining, other modalities, including PCR, immunofluorescence, electron microscopy, and immunohistochemistry, are typically utilized to confirm the pathogen involved in these cases. We review the reports of balamuthosis in animals.

Pourbagher-Shahri, A. M., Mohammadi, G., Ghazavi, H., and Forouzanfar, F. (2023). Susceptibility of domestic and companion animals to SARS-CoV-2: A comprehensive review. Tropical Animal Health and Production, 55(1), 60.

ASBTRACT

The ongoing coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has caused a large global outbreak. The reports of domestic animals' infection with SARS-CoV-2 raise concerns about the virus's longer-lasting spread, the establishment of a new host reservoir, or even the evolution of a new virus, as seen with COVID-19. In this review, we focus on the susceptibility of domestic animals, especially companion animals, towards SARS-CoV-2 in light of existing studies of natural infection, experimental infection, and serological surveys.

Ready, Z. C., LoBato, D., LaDouceur, E., Garner, M. M., and Cushing, A. C. (2023). Melanocytic neoplasia in Panthera species: Clinical presentations, pathologic findings and responses to treatment. Journal of Zoo and Wildlife Medicine, 53(4), 844.

ABSTRACT

Neoplasia is a common cause of morbidity and mortality in captive nondomestic felids. Seven tigers (Panthera tigris), two African lions (Panthera leo), and two snow leopards (Panthera uncia) were diagnosed with melanocytic neoplasia (10 malignant melanomas, two benign melanocytomas) over a 20-yr period. Animals were 10-19 yr old and 5/7 tigers were phenotypically white. Malignant melanoma tumor location included skin (n = 4), oral mucosa (n = 2), nasal planum (n = 1), iris/uvea (n = 2), and lip margin (n = 1); melanocytomas were found in skin (n = 2). Metastasis to regional lymph nodes was seen at diagnosis in 3/7 melanoma cases.

Thoracic radiography (n = 6) and/or computed tomography (n = 2) did not detect pulmonary metastasis at diagnosis but were useful for detection later in the disease course. Median survival time (MST) for all cases ranged from 1 mon - 40 mon. Seven cases with malignant melanoma underwent treatment, which included surgery, radiation therapy, and administration of the canine melanoma vaccine (Oncept®) or a combination of these treatments; MST was 5-40 mon for these cases. While multimodal therapy may provide an improved survival time, the majority of animals with malignant melanoma invariably died from neoplastic disease. Necropsy confirmed metastasis of malignant melanoma in 7/9 animals; sites included lung, liver, lymph node, kidney, mesentery, pleural cavity, heart, stomach, spleen, and adrenal gland. This case series describes the clinical and histologic findings of melanocytic neoplasia in nondomestic felids as well as multimodal treatment strategies incorporating the canine melanoma vaccine.

Smith, C. K., Chow, N., Zhu, X., and Cushing, A. C. (2023). Evaluation of agreement between oscillometric and direct blood pressure measurements in anesthetized tigers (Panthera tigris). Journal of Zoo and Wildlife Medicine, 53(4), 777.

ASBTRACT

Noninvasive blood pressure measurement is commonly performed with oscillometry; however, this technique provides clinically helpful information only if it is representative of the gold standard. Agreement between direct and oscillometric blood pressure measurements were performed in 14 anesthetized, captive tigers (Panthera tigris). A cuff, placed around the tail base and connected to a multiparameter monitor, was used to measure arterial blood pressure oscillometrically and provided systolic, mean, and diastolic pressures. At the same time, direct blood pressures were obtained from a dorsal pedal arterial catheter, and the oscillometric and direct readings were considered paired data points. Agreement between the two methods was evaluated by Bland-Altman plots. All animals completed the study and provided 196 paired data points. The bias (mm Hg) for systolic, mean, and diastolic arterial pressures was -3.7, -0.8, and -1.6, respectively. Limits of agreement (mm Hg) for systolic, mean, and diastolic arterial pressures were -31 to 24, -29 to 27, and -29 to 26, respectively. Oscillometry provided an acceptable amount of readings within 10 and 20 mm Hg of the gold standard. The oscillometric technique provided reasonable agreement with direct measurements. Therefore, in the conditions used in this study, oscillometric blood pressure measured via the ventral coccygeal artery provided reasonable estimates of invasive blood pressure in anesthetized tigers.

Tewari, D., Miller, R., Livengood, J., Wang, L., Killian, M. L., Bustamante, F., ... Rosenberg, J. (2023). SARS-CoV-2 infection dynamics in the Pittsburgh Zoo wild felids with two viral variants (Delta and Alpha) during the 2021–2022 pandemic in the United States. Animals, 13(19), 3094.

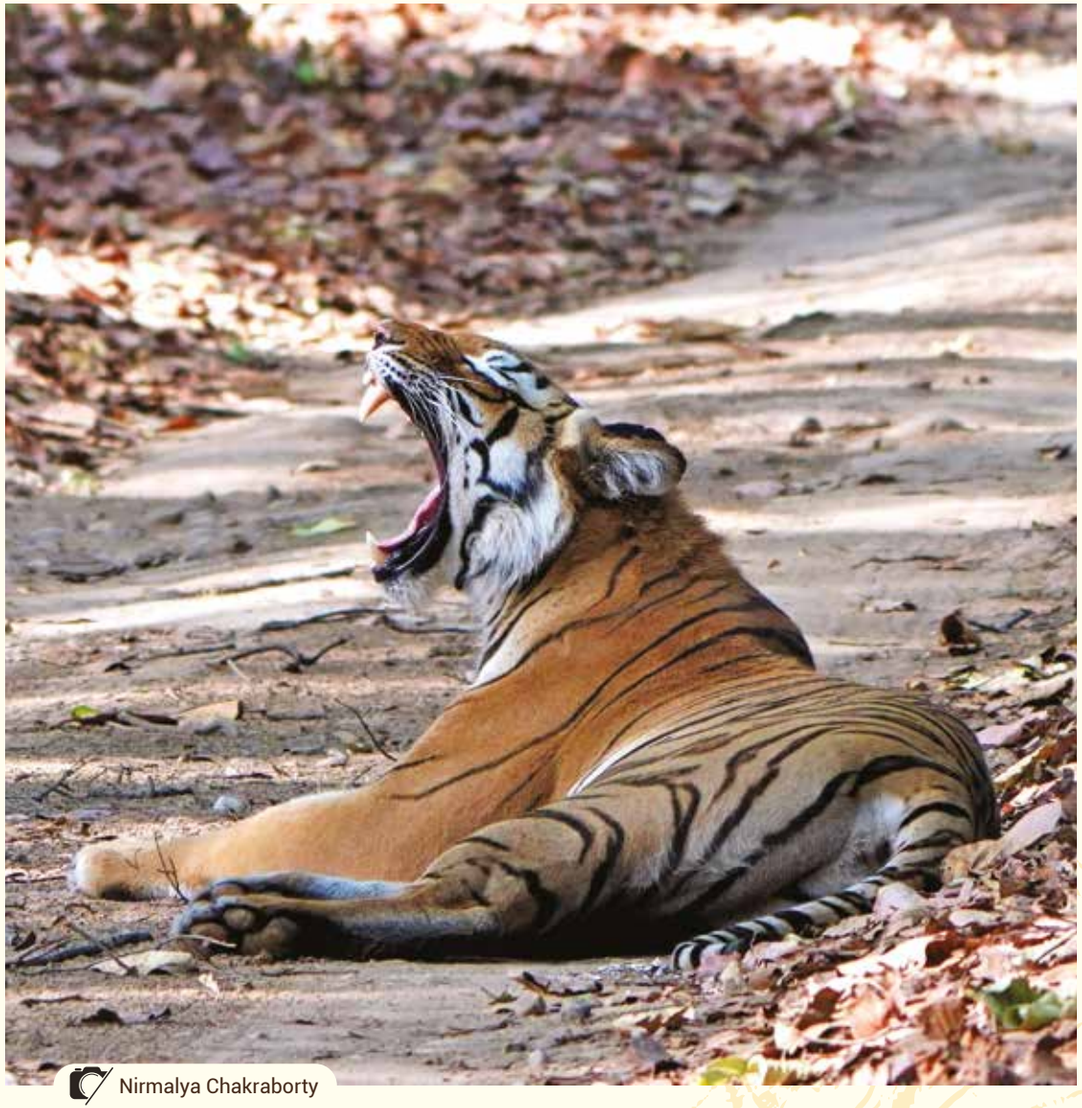
ASBTRACT

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has been reported in multiple animal species besides humans. The goal of this study was to report clinical signs, infection progression, virus detection and antibody response in a group of wild felids housed in adjacent but neighboring areas at the Pittsburgh Zoo. Initially, five African lions (Panthera leo krugeri) housed together exhibited respiratory clinical signs with viral shedding in their feces in March of 2021 coinciding with infection of an animal keeper. During the second infection wave in December 2021, four Amur tigers (Panthera tigris altaica) and a Canadian lynx (Lynx canadensis) showed clinical signs and tested positive for viral RNA in feces. In infected animals, viral shedding in feces was variable lasting up to 5 weeks and clinical signs were observed for up to 4 weeks. Despite mounting an antibody response to initial exposure, lions exhibited respiratory clinical signs during the second infection wave, but none shed the virus in their feces. The lions were positive for alpha variant (B.1.1.7 lineage) during the first wave and the tiger and lynx were positive for delta variant (AY.25.1. lineage) during the second wave. The viruses recovered from felids were closely related to variants circulating in human populations at the time of the infection. Cheetahs (Acinonyx jubatus) in the park did not show either the clinical signs or the antibody response.

Yeo, Y.-G., Kim, H.-R., Park, J., Kim, J.-M., Shin, Y.-K., Lee, K.-K., ... Park, C.-K. (2023). Epidemiological and molecular approaches for a fatal feline panleukopenia virus infection of captive Siberian tigers (Panthera tigris altaica) in the Republic of Korea. Animals, 13(18), 2991.

ABSTRACT

Feline panleukopenia virus (FPV), a member of the species Protoparvovirus carnivoran1, is one of the most fatal pathogens of domestic and wild carnivores. The virus endemically infects domestic carnivores worldwide and its cross-species transmission threatens endangered wild carnivores, including Siberian tigers. In this study, a fatal FPV infection in endangered Siberian tigers was investigated to trace the origin of the virus and elucidate the reason behind FPV's infection of the vaccinated tigers. Our genetic characterization and phylogenetic analysis revealed that the virus detected in the infected tigers, designated as the KTPV-2305 strain, was closely related to FPV strains circulating in Korean cats, suggesting that it might have been transmitted from stray cats wandering around the zoo. Compared with the prototype FPV reference strains, the KTPV-2305 strain carried three distinct amino acid (aa) mutations in the VP2 protein sequence (I101T, I232V, and L562V) in this study. These three mutations are commonly found in most global FPV strains, including Korean strains, indicating that these mutations are common evolutionary characteristics of currently circulating global FPVs. The reason why the vaccinated tigers were infected with FPV was most likely the insufficient protective immunity of the affected tigress or vaccine failure triggered by the interference of maternal-derived antibodies in the affected tiger cubs. These findings suggest that improved vaccination guidelines are urgently needed to save the lives of wild carnivores from this fatal virus.



Nirmalya Chakraborty

INDIA

SUSTAINABLE SOLUTIONS AND TECHNOLOGY

Dertien, J.S., Negi, H., Dinerstein, E., Krishnamurthy, R., Negi, H.S., Gopal, R., Gulick, S., Pathak, S.K., Kapoor, M., Yadav, P., and Benitez, M. 2023. Mitigating human–wildlife conflict and monitoring endangered tigers using a real-time camera-based alert system. BioScience, 73(10), pp.748-757.

ABSTRACT

The recovery of wild tigers in India and Nepal is a remarkable conservation achievement, but it sets the stage for increased human–wildlife conflict where parks are limited in size and where tigers reside outside reserves. We deployed an innovative technology, the Trail Guard AI camera-alert system, which runs on-the-edge artificial intelligence algorithms to detect tigers and poachers and transmit real-time images to designated authorities responsible for managing prominent tiger landscapes in India. We successfully captured and transmitted the first images of tigers using cameras with embedded AI and detected poachers. Notifications of tiger images were received in real time, approximately 30 seconds from camera trigger to appearing in a smart phone app. We review use cases of this AI-based real-time alert system for managers and local communities and suggest how the system could help monitor tigers and other endangered species, detect poaching, and provide early warnings for human–wildlife conflict.

Shanu S., Agarwal A. (2023). A Computational Model for Determining Tiger Dispersal and Related Patterns in a Landscape Complex. Sustainability. 2023; 15(11):8539. *https://doi.org/10.3390/su15118539*.

ABSTRCAT

Species dispersal from one territorial zone to another is a complex process. The reasons for species dispersal are determined by both natural and human factors. The purpose of this study is to develop a cost surface for a hypothetical landscape that accounts for various species dispersion features. With tigers (Panthera tigris tigris) as the focal species, a computational model for a landscape has been proposed to predict the dispersion patterns of the species' individuals from one habitat patch to another. Knowing how tigers disperse is very crucial because it improves the likelihood of successful conservation. The likelihood is raised because it strengthens conservation efforts in the targeted regions identified by the proposed model and encourages landscape continuity for tiger dispersal. Initially, four major factors influencing tiger dispersal are explored. Following that, grids are overlaid over the tiger-carrying landscape map. Further, game theory assigns a score to each grid in the landscape matrix based on the landscape features in the focal landscape. Specific predefined ratings are also utilized for scenarios that are very complex and may change depending on variables, such as the interaction of the dispersing tiger with co-predators. The two scores mentioned above are combined to create a cost matrix that is shown across a landscape complex to estimate the impact of each landscape component on tiger dispersal. This approach helps wildlife managers develop conservation plans by recognizing important characteristics in the landscape. The results of the model described in this work might be beneficial for a wide range of wildlife management activities, such as corridor management, smart patrols, and so on. A cost surface over any focal landscape may serve as a basis for policy and purpose design based on current landscape conditions.

Nirmalya Chakraborty

Sharma, R., Barnes, M., Bista, A., and Gordon, A. (2023). Putting technology between people and tigers. Anim Conserv, 26: 277-278. *https://doi.org/10.1111/acv.12850*.

ASBTRACT

Underutilization of technology in South Asia for tiger conflict management is due to high costs, reluctance to adopt new technology, and perceived uncertainty in its effectiveness. Investment

in new technology for conflict prevention and mitigation is more cost-effective than traditional approaches. Collaboration among tiger range countries in research and development can reduce technology deployment costs and provide local employment opportunities. Centralized mobile applications can be used for reporting tiger presence and behavior, reducing conflicts. Non-imaging sensors, non-lethal deterrents, and electric fencing are potential approaches for tiger conflict management. Identification, capture, and rehabilitation of problem tigers is difficult and time-consuming, requiring intensive camera trap arrays. Compensation payments by governments are often slow and inadequate for proactively mitigating conflicts.

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATIONS

Choudhary, R., Dahiya, S., and Choudhury, T. (2023). A review of tiger conservation studies using nonlinear trajectory: A telemetry data approach. Nonlinear Engineering, 12(1), 2022-0235. *https://doi.org/10.1515/nleng-2022-0235*.

ABSTRACT

Radio telemetry is being used in India to capture the location and movements of radio-collared wild animals. Radio telemetry data analysis has changed the scenario for wildlife conservation. It has provided many models and solutions for natural habitat utilization, genetic diversity, and even implementing green corridors for the species. Insights drawn from the data collected through radio telemetry from radio-collared animals have provided impactful information to understand the wild animal's ecology. In the past few years, India has remarkably improved the population of tigers using telemetry studies and other conservation methods. In this study, a review of the telemetry studies conducted for tigers in India in the past decade has been presented. This study summarizes the telemetry studies of tigers in India and discusses how telemetry has enhanced the knowledge of ecologists and scientists to understand tiger ecology. This study also discusses the challenges and issues of conducting telemetry studies on tigers in India. Finally, the authors address the gaps in understanding the tiger's ecology based on these studies and outline how radio telemetry can address these issues to better understand and conserve tigers.

Khan, S. (2023). Anthropogenic threats and conservation practices: Evaluating LULC changes in relocated villages of Panna Tiger Reserve, Madhya Pradesh, India. bioRxiv. doi: *https://doi.org/10.1101/2023.03.08.531715*.

Protected areas globally, including India, face anthropogenic threats despite environmental and forest protection laws. To reduce these pressures, conservation related settlement evacuation from protected areas has been a common conservation practice for decades in many countries.

Controversies aside, studies have shown that evacuation of settlements from protected areas has a positive impact on forest cover change and biodiversity increase. Here in this study, we conducted this study for the 14 relocated village sites of Panna Tiger Reserve to see the changes in major Land use Land cover changes over 15 years (2004-2019). We observed a significant increase in forested areas in those regions over time, as well as prominent changes in different land cover classes. The increase in Grassland, Open Forest, and Dense Forest from 2004 to 2019 was significant, and settlements in relocated areas were mainly converted to different forest types. Additionally, fieldwork and camera trap data showed that the relocated sites with established woodlands and other forest classes supported higher animal diversity and species composition compared to other sites. This study provides a knowledge base for conservation and management practices by identifying significant changes in various land use and land cover classes.

Madhya Pradesh Forest Department & State Forest Research Institute. (2023). International Conference on Wildlife Conservation: Emerging Scenario and Way Forward. Kahna Tiger Reserve, Mandala (M.P.), India.

BACKGROUND

The state of Madhya Pradesh, often referred to as the "Heart of India," occupies a substantial area in central India, encompassing approximately 3,08,252 km². Renowned for its abundant forests, it boasts a Recorded Forest Area (RFA) covering 94,689 km². Among these, 61,886 km² are categorized as Reserved Forests, 31,098 km² as Protected Forests, and 1,705 km² as unclassified Forests. This state stands out as a wildlife haven, featuring 25 Wildlife Sanctuaries and ten National Parks, offering exceptional opportunities for nature enthusiasts, environmentalists, and wildlife lovers to observe diverse wildlife thriving in their natural habitats. Madhya Pradesh has been a key contributor to India's wildlife conservation initiatives, especially during a period when several wildlife species face decline. Notably, it holds the distinction of harboring the largest tiger population in the country. Additionally, the region boasts the highest leopard population and is home to endangered vultures and the 'endemic' crocodile-gharial. The state has made significant strides in augmenting the population of the highly endangered Barasingha and successfully reintroducing the Indian Bison (Gaur). The Madhya Pradesh Forest Department has been dedicatedly safeguarding the natural ecosystems and wildlife habitats for several years.

Recently, an ambitious project was initiated in Madhya Pradesh under the Trans-Continental Wild Cheetah Rehabilitation Program, inaugurated by the Honorable Prime Minister of India, Shri Narendra Modi, aiming to reintroduce cheetahs to the Kuno-Palpur National Park.

Madhya Pradesh has a strong legacy of scientifically managing and conserving wildlife, including tigers, leopards, crocodiles, and vultures, within the country. The pivotal guidance and contributions of the Honorable Chief Minister of the State, Shri Shivraj Singh Chouhan, have been instrumental in these achievements.

In commemoration of 100 years of forestry research in Madhya Pradesh and in alignment with the manifesto of the Honorable Chief Minister, a three-day International Wildlife Conference took place at Kanha National Park from April 27 to 29, 2023. The conference aimed to convene wildlife experts, researchers, forestry professionals, NGOs, and wildlife law experts on a unified platform to deliberate on current scenarios concerning wildlife management, conservation, and rehabilitation. Distinguished personalities such as wildlife expert and Padma Bhushan recipient Dr. H.S. Pawar, alongside internationally renowned wildlife experts from America, Europe, South Africa, and Namibia, actively participated in this significant event.

The primary objective of this conference was to derive comprehensive strategies that blend the economy and ecology, aligning with the vision of the Honorable Prime Minister of India, for the nation's holistic and progressive development in the "Amritkaal of the Nation.

Mungi, N. A., Qureshi, Q., & Jhala, Y. V. (2023). Distribution, drivers and restoration priorities of plant invasions in India. Journal of Applied Ecology, 60, 2400–2412.
https://doi.org/10.1111/1365-2664.14506.

ABSTRACT

Biological invasions threaten biodiversity and human wellbeing, with developing tropical countries being more vulnerable. Despite the urgency to reduce impacts of invasions, management interventions are constrained by unavailability of timely information on invasive species occurrence, potential drivers and restoration priorities. Generating this information at biogeographic scales can be costly, unless integrated with multi-objective biodiversity monitoring.

Invasive plant monitoring is integrated with India's national-scale tiger population assessment, wherein natural areas are sampled at 25 km^2 scale to inventory plants. In 2018, a total of 158,979 plots were sampled covering ~358,550 km^2. We used 206,393 locations of high concern invasive plants to model their distribution using socio-ecological covariates and identify potential drivers of invasions. Considering the invasion magnitude and financial constraints in management, we further identified priority restorations sites at national-scale to maximise biodiversity outcomes.

High-concern invasive plants were recorded from ~254,880 km^2 (72% sampled area) and modelled to invade in total ~750,905 km^2 (66%) Indian natural systems. While open and deciduous ecosystems were the highest invaded by woody plants, areas with extreme climate and less anthropic pressure were least invaded. Since managing invasions across their range seemed futile due to costly (~13.5 billion USD for one-time management) and ineffective strategies, restoration priority was assigned to least invaded areas (11% protected areas, 23% multi-use) to maximise biodiversity returns.

Synthesis and applications: India implemented national-scale invasive plant monitoring by integrating it with the umbrella project on tiger assessment. Embarking on this big data, we show that two-thirds of India's natural areas are under multiple plant invasions, owing to the legacy of anthropogenic modifications. Our study offers a restoration priority model, empowering policymakers to devise adaptive strategies for restoring invaded biomes and maximizing biodiversity returns.

Lyngdoh, A. W., Kumara, H. N., Babu, S., and Karunakaran, P. V. (2023). Community reserves: Their significance for the conservation of mammals in a mosaic of community-managed lands in Meghalaya, Northeast India. PLoS ONE, 18(1), e0280994.
https://doi.org/10.1371/journalpone.0280994.

ABSTRACT

Community Reserves (CRs) have been advocated for increasing the protected area coverage in northeast India where the land is primarily owned and managed by local indigenous institutions. To understand the significance of these reserves for the conservation of mammals, we investigated the diversity and abundance of mammals in five CRs in the Khasi Hills of Meghalaya as well as interviewed 75 local villagers to assess the hunting practices and perceptions of the Indigenous Khasis on mammals. We employed 60 camera traps in the CRs and undertook a recce survey (day-time and night-time) for capturing the diversity in the CRs. We used photo-capture rate and encounter rate as indices of relative abundance in the CRs. We used an exact multinomial test to test differences of opinion among the respondents of the five CRs. We found a relatively low abundance of mammals in the CRs, yet they persist. A total of 28 species were detected through camera trapping and recce survey and an additional 12 species were reported by respondents to also occur in the CRs. Among the respondents, it was believed that the decline in mammal populations was largely driven by habitat loss and degradation (82.67%) while only a few believed it was also driven by hunting (5.33%). Respondents also believed that the presence of the reserves and awareness programs taken under them had also led to a reduction in hunting (20%) in their area. Although, some attributed it to a general decline in wildlife populations and forest cover (21.33%). Thus, despite these CRs being small (<2 km^2)

and isolated, they still harbour mammal species and are important for retaining remnant forest patches in a landscape that is highly fragmented.

Mallick, J. K. (2023). Conservation status of Bengal tiger Panthera tigris tigris in the earth's only mangrove tigerland: A review of efforts and challenges. Probe - Animal Science, 5(1), 1777.

ABSTRACT

Sundarban is the earth's largest contiguous 'mangrove forest' ('Bādābān') designated as protected or conservation areas including biosphere reserve, tiger reserve, core area, critical tiger habitat, primitive (wilderness) zone, national park, wildlife sanctuaries, buffer area and reserved forests, covering 10,277 km^2 forest area [4260 km^2 (41.45%) in India and 6017 km^2 (58.55%) in Bangladesh]. This natural biodiversity hotspot is the only mangrove tigerland and the 'last stronghold' of Panthera tigris tigris with a camera trap-based population estimate of 214 (100 in Indian Sundarbans and 114 in Bangladesh Sundarbans) supported by a creek (sign) survey. Globally, Sundarban is a prioritised class I tiger conservation landscape extending over 5304 km^2 or 51.6% of total terrestrial and aquatic mangrove habitat in the region, which is facing emergent conservation challenges due to natural and anthropogenic threats. Several conservation actions have been executed to stabilise and increase the tiger population. There is cause for 'cautious future optimism' since the trend of historically high rates of mangrove clearing and degradation has slowed down and tiger population in the Sundarban mangroves has slightly increased and remains stable during the last three enumerations (2018–2022) in India (the results of the current camera-based census in Bangladesh counterpart are to be announced on 29 July 2024), which can be attributed to some positive improvements of tiger habitat management.

Oinam, M. (2023). Tiger Conservation Plan. TIJER, 10(5), 840-847.

The primary goal of this research paper is to analyse the Tiger Conservation Plan in India and its effectiveness, which aims to protect the world's largest population of tigers from habitat loss, poaching, and human-tiger conflict. Through a review of literature and analysis of data, the paper examines the strategies used in the plan, including protected area management, community participation, and scientific research. The results of the plan are evaluated through the latest tiger census conducted in 2018, which shows an increase in the tiger population in the country. The paper also discusses the challenges that remain in tiger conservation, such as habitat fragmentation and climate change, and offers suggestions for future research and policy development.. This paper concludes that the tiger conservation plan in India is a successful example of conservation efforts that involve a combination of protected area management, community participation, and scientific research. The plan has increased the population of tigers, reduced human-tiger conflict, and reduced poaching. The continued monitoring and adaptation of conservation strategies are essential for the long-term survival of tigers and their habitats.

Climate Change

Deka, J. R., Ali, S. Z., Ahamad, M., Borah, P., Gopi, G. V., Badola, R., Sharma, R., and Hussain, S. A. (2023). Can Bengal Tiger (Panthera tigris tigris) endure the future climate and land use change scenario in the East Himalayan Region? Perspective from a multiple model framework. Ecology and Evolution, 13(8), e10340.

ABSTRACT

Large mammals are susceptible to land use and climate change, unless they are safeguarded within large, protected areas. It is crucial to comprehend the effects of these changes on mammals to develop a conservation plan. We identified ecological hotspots that can sustain an ecosystem for the endangered Bengal tiger (Panthera tigris tigris), an umbrella species.

Dhritiman Mukherjee

We developed three distinct ensemble species distribution models (SDMs) for the Bengal tiger in the Indian East Himalayan Region (IEHR). The first model served as the baseline and considered habitat type, climate, land cover, and anthropogenic threats. The second model focused on climate, land use, and anthropogenic threats, the third model focused on climate variables. We projected the second and third models onto two future climate scenarios: RCP 4.5 and RCP 8.5. We evaluated the threats possess to protected areas within eco-sensitive zone based on the potential tiger habitat. Finally, we compared the potential habitat with the IUCN tiger range. Our study revealed that the Brahmaputra valley will serve as the primary habitat for tigers in the future. However, considering the projected severe climate scenarios, it is anticipated that tigers will undergo a range shift towards the north and east, especially in high-altitude regions. Very high conservation priority areas, which make up 3.4% of the total area, are predominantly located in the riverine corridor of Assam. High conservation priority areas, which make up 5.5% of total area are located in Assam and Arunachal Pradesh. It is important to note that conservation priority areas outside of protected areas pose a greater threat to tigers. We recommend reassessing the IUCN Red List's assigned range map for tigers in the IEHR, as it is over-predicted. Our study has led us to conclude both land use and climate change possess threats to the future habitat of tigers. The outcomes of our study will provide crucial information on identifying habitat hotspots and facilitate appropriate conservation planning efforts.

Illegal Trade/Crime

Rana, A.K., and Kumar, N. (2023). Current wildlife crime (Indian scenario): major challenges and prevention approaches. Biodiversity and Conservation, 32, 1473–1491. *https://doi.org/10.1007/s10531-023-02577-z.*

ABSTRACT

The constant depletion of wild flora and fauna in India due to uncontrolled human activities, natural habitat destruction and covert poaching activities is threatening the ecological balance. The poaching and trafficking of wild species in the lure of money as well as fashion has wiped out a range of wildlife species that call for critical attention to tackle this menace. There are many transit routes through the states of Uttar Pradesh, Karnataka, West Bengal, Rajasthan, Madhya Pradesh, and Assam, which are major hubs for wildlife trafficking in India, in both domestic and international markets. The poaching of wild animals and plants slowly erases biodiversity, which in turn affects the survival of humans and other living species. Therefore, there is an urgent need to check ongoing wildlife crimes, raise the number of endangered species, rehabilitate exotic/extinct species and restore natural ecosystems. In this article, we collected wildlife crime data from web portals of various stakeholders, government agencies and authentic news sources, and discuss the current crime trends, challenges, and prevention approaches required to control and restore wildlife biodiversity in India.

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Bhatt, U., and Lyngdoh, S. (2023). Do dholes segregate themselves from their sympatrids? Habitat use and carnivore co-existence in the tropical forest. Mammalian Biology, 103, 591–601. *https://doi.org/10.1007/s42991-023-00378-z*

ABSTRACT

The dhole or Asiatic wild dog Cuon alpinus is the only endangered social canid in the tropical Indian forests and is considered at high risk of extinction in the wild. Despite this, knowledge about its ecology is still scarce. We investigated relative abundance, habitat utilisation and spatial and temporal ecology of dholes in Manas National Park, North-East India. Camera traps (n = 473) were deployed across forested habitats of Manas for 11,388 trap nights. Independent records and relative abundance index were 163 and 1.431 ± 0.387 SE per 100 trap nights, respectively. Dhole habitat use exhibited a non-significant relationship with habitat and anthropological variables. The availability of small prey, i.e., rhesus macaque, showed a tendency of a positive association with dhole habitat use and, therefore, intrinsically highlights the potential conservation importance of small prey species. Low temporal overlaps (< 0.50) were observed between dhole and other sympatric carnivores. Dholes showed a positive co-occurrence pattern with tigers and leopards. To coexist, dholes segregate themselves from other sympatric carnivores, primarily by utilising different temporal niches and adjusting their activity peaks when encountering them. This spatio-temporal segregation suggests a partial avoidance of dholes from dominant predators that may decrease competition and the risk of intraguild predation.

Biswas, S., Kumar, S., Bandhopadhyay, M., Patel, S. K., Lyngdoh, S., Pandav, B., and Mondol, S. (2023). What drives prey selection? Assessment of Tiger (Panthera tigris) food habits across the Terai-Arc Landscape, India. Journal of Mammalogy. *https://doi.org/10.1093/jmammal/gyad069*.

ABSTRACT

Large carnivores strongly shape ecological interactions within their respective ecosystems, but experience significant conflicts with humans across their range due to their specific ecological resource requirements. The Tiger (Panthera tigris) typifies the challenges faced by large carnivore species globally. India retains the majority of the global Tiger population

with a substantial number occurring outside protected areas where they are prone to conflict through livestock predation and injury or death to people and Tigers. Tiger food habits was investigated across the Indian part of the Terai-Arc Landscape (TAL), a globally important Tiger conservation landscape, to understand Tiger prey selection patterns and hotspots of livestock predation-related conflict. 510 genetically confirmed Tiger feces were collected across the landscape and 10 wild ungulates and livestock as prey species were identified. Large-bodied species (Sambar, Swamp Deer, Nilgai, Chital, Wild Pig, and livestock) comprised ~94% of the diet, with Sambar, Chital, and livestock having the highest relative proportions. Habitat-specific (Shivalik-Bhabar and Terai) analyses indicate that prey selection is driven by prey abundance and body weight but not determined by protection status (protected areas vs non-protected areas). Results also suggest that PAs and non-PAs in the Terai region were more prone to livestock predation-related conflict. Careful management interventions with community involvement should be utilized to reduce such threats. In this study, we suggest long-term conservation plans including prey abundance estimation outside PAs, reduction of grazing pressures, and detailed records of Tiger mortalities with causal investigations to ensure future conflict-free Tiger persistence across TAL.

Milda, D., Ashish, K., Ramesh, T., Kalle, R., and Thanikodi, M. 2023. Evaluation of anthropogenic pressure on the occupancy patterns of large mammals in the Western and Eastern Ghats. Landscape Ecology, 38(2), pp.409-422.

ABSTRACT

Context
Habitat loss limits the dispersal of wide-ranging large mammals. It is pivotal to study the ecological and anthropogenic factors driving the habitat occupancy of large mammals for their long-term conservation and reduction of negative human–wildlife interactions.

Objective
To evaluate how the habitat occupancy pattern of the large mammals varies across a gradient of anthropogenic pressures.

Methods
We conducted ecological sign surveys across nine forest divisions including, Protected Areas (PAs) and outside PAs, along the Western and Eastern Ghats of Tamil Nadu, India. We used systematic grid-based Markovian occupancy model to study the effect of ecological and anthropogenic variables (prey abundance, habitat features, direct human disturbance and habitat fragmentation) on tiger (Panthera tigris), leopard (Panthera pardus), dhole (Cuon alpinus), elephant (Elephas maximus) and gaur (Bos gaurus) occupancy at 100 km2scale.

Results
Tiger and dhole occupancy was driven by the abundance of large and medium-sized prey. However, leopards also relied on the available small prey species and utilised fragmented forest patches. Large mammal occupancy increased in contiguous forests with water availability and decreased in landscapes with increased human disturbances and habitat fragmentation. Tiger occupancy was highly confined towards contiguous PA network while the rest of them had scattered but concentrated occupancy towards PAs.

Conclusions
The dependency of large mammals on contiguous forests suggests improving the quality and connectivity of forested habitats for their dispersal and reducing negative human–wildlife interactions. The low occupancy areas require urgent habitat management intervention to reduce grazing pressure and restore degraded habitats to sustain viable large mammal population at landscape-level.

Chatterjee, A. B., Sankar, K., Sankar, K., Jhala, Y. V., and Qureshi, Q. (2023). Spatio-temporal patterns of co-occurrence of tigers and leopards within a protected area in central India. Web Ecology, 23, 17-34.

The global decline of large carnivore populations warrants scientific insights into intraguild relationships. Patterns of co-occurrence among sympatric predators are governed by their density, distribution, diet, activity overlaps, and behavioural strategies. Tigers are sympatric with leopards across their distribution range, overlap substantially in their diet, and are both nocturnal. The subdominant leopard is believed to coexist with tigers via several mechanisms like spatial segregation, temporal avoidance, and differential prey selection. Investigation of spatio-temporal patterns of co-occurrence of tigers and leopards can provide insights on mechanisms that permit coexistence. We used camera trap-based photo captures of tigers and leopards in prey-rich (58.15±10.61 ungulates per km^2) Pench Tiger Reserve to determine their spatio-temporal patterns of co-occurrence. Spatially explicit density estimates of tigers were approximately 5 per 100 km^2 and leopards were approximately 4.5 per 100 km^2 and remained stable over the years. This implies that both these co-predators are likely to attain carrying capacity within the study area. Areas with high tiger density had lower leopard density. Quantile regression analysis between tiger and leopard density at 2×2 km grid showed that leopard density had a parabolic relationship with tiger density, initially increasing with tigers (β=0.393; p=0.001), stable at medium tiger density (β=0.13 and p=0.15), and declining at high tiger densities (β=-0.37 and p<0.001). Both tigers and leopards were crepuscular in nature with no temporal segregation (Δ=89 %). Time lag of consecutive leopard photograph after a tiger capture ranged between 0.002 to 36.29 d. Leopard use of trails was not related to use by tigers. Our results suggest that leopards adjust their usage of space at fine scales

to avoid confrontations with tigers. We also observed high temporal overlap and no spatio-temporal segregation between tigers and leopards, despite the two predators being nocturnal and having similar prey choices. The availability of ample prey within the study area is likely to be the driving factor of the co-occurrence of tigers and leopards within this dry deciduous habitat of central India.

Choudhary, R., Choudhury, T., and Dahiya, S. (2023). Exploring tiger movement pattern according to prey context: a case study in Sundarbans region of India. Spatial Information Research, 31(6), 597-608.

ABSTRACT

The Sundarbans national park is 10,000 square kilometers tidal mangrove forest in India and Bangladesh and is home to the largest population of Bengal tigers in the world. However, Sundarbans tigers are facing numerous threats such as Habitat loss, land fragmentation, poaching, and prey depletion. For effective conservation efforts, it is crucial to understand the behavior and movements patterns of these tigers within their habitat. In this study on the Sundarbans region, telemetry data analysis is done which is obtained from WII (Wildlife Institute of India) for four tigers with 4000 GPS locations along with prey distribution dataset. Using Machine Learning algorithms like Ridge regression, KNN (K-Nearest Neighbor), Decision tree, SVM (Support Vector Machine) and MLP (Multi-Layer Perceptron), the proposed model predicts each predator's next location based on predator- prey locations and neighboring predator interaction with different combinations of predator-prey categories before comparing results among all algorithms. The results showcased that among all ML algorithms, Decision Tree algorithm produced best results with highest accuracy rate of predicted predator location compared to actual location. This analysis provides input that can be used to develop more effective conservation strategies to combat poaching.

David M., Ashish, K., Ramesh, T., Kalle, R., and Thanikodi, M. (2023). Evaluation of anthropogenic pressure on the occupancy patterns of large mammals in the Western and Eastern Ghats. Landscape Ecology, 38(2), 409-422.

ABSTRACT

Context: Habitat loss limits the dispersal of wide-ranging large mammals. It is pivotal to study the ecological and anthropogenic factors driving the habitat occupancy of large mammals for their long-term conservation and reduction of negative human–wildlife interactions.

Objective: To evaluate how the habitat occupancy pattern of the large mammals varies across a gradient of anthropogenic pressures.

Methods: We conducted ecological sign surveys across nine forest divisions including, Protected Areas (PAs) and outside PAs, along the Western and Eastern Ghats of Tamil Nadu, India. We used systematic grid-based Markovian occupancy model to study the effect of ecological and anthropogenic variables (prey abundance, habitat features, direct human disturbance and habitat fragmentation) on tiger (Panthera tigris), leopard (Panthera pardus), dhole (Cuon alpinus), elephant (Elephas maximus) and gaur (Bos gaurus) occupancy at 100 km^2 scale.

Results: Tiger and dhole occupancy was driven by the abundance of large and medium-sized prey. However, leopards also relied on the available small prey species and utilised fragmented forest patches. Large mammal occupancy increased in contiguous forests with water availability and decreased in landscapes with increased human disturbances and habitat fragmentation. Tiger occupancy was highly confined towards contiguous PA network while the rest of them had scattered but concentrated occupancy towards PAs.

Conclusions: The dependency of large mammals on contiguous forests suggests improving the quality and connectivity of forested habitats for their dispersal and reducing negative human–wildlife interactions. The low occupancy areas require urgent habitat management intervention to reduce grazing pressure and restore degraded habitats to sustain viable large mammal population at landscape-level.

Franchini, M., and Guerisoli, M. M. (2023). Interference competition driven by co-occurrence with tigers may increase livestock predation by leopards: a first step meta-analysis. Mammal Review, 53(4), 271-286.

ABSTRACT

In coexisting carnivorans (Carnivora) relying on the same food resources, the dominant species imposes a cost on the inferior competitor by limiting its foraging ability. Tigers Panthera tigris and leopards Panthera pardus live in sympatry in most Asian countries and, because of their similar trophic niche, 'interference competition' may exist between these two predators. In fact, since tigers generally occupy prime habitats, leopards could be forced to roam into peripheral areas that are heavily used by humans to avoid competition, consequently increasing the risk of human-leopard conflicts.

Using information collected from the reviewed scientific literature, the purposes of this work were: 1) to assess if livestock predation by leopards increases in areas of coexistence with

tigers, and 2) to characterise leopard attacks on livestock to discern the main factors involved in the human-leopard conflict.

Our findings showed that the leopard's 'overall' livestock predation rate (i.e. individuals taken/year) was higher in the absence of tigers than in their presence, and the same was observed for the 'sheep and goat' predation rate. These results confirm the leopard's tendency to take livestock and, especially, smaller prey. Conversely, the 'cattle' and 'other' predation rates were higher in the presence of tigers than in their absence, suggesting the existence of a sort of spatial segregation between predators in certain contexts. Lower levels of predation by leopards were observed on farms in which more prevention measures were used, than in those in which only one measure was implemented.

We stress the importance of using proper prevention measures to mitigate human-leopard conflicts. However, because their implementation may not be easy or economically feasible, the financial support given by carnivoran-policy makers assumes remarkable importance to minimise the economic impact on local families and, in turn, to foster the coexistence between leopards and humans in shared landscapes.

Latafat, K., Sadhu, A., Qureshi, Q., et al. (2023). Abundance and activity of carnivores in two protected areas of semi-arid western India with varying top predator density and human impacts. European Journal of Wildlife Research, 69, 15.
https://doi.org/10.1007/s10344-023-01643-9

ABSTRACT

Large carnivores are vulnerable to population decline due to their k-selected traits in fragmented human-dominated landscapes. In the semi-arid landscape of western India, tiger (top predator) populations went locally extinct from most of the forested ecosystems, while the mesopredators (leopards, hyenas, wolves) managed to survive in these mosaics of forest, agriculture, pasturelands, ravines, and human habitations. In this study, we used camera traps to survey two protected areas (PAs) in the semi-arid western Indian landscape—Mukundara (without tigers) and Ranthambhore (with high-density tiger population)—and compare the abundance and activity of mesopredators between sites to assess the effect of top predator presence on mesopredators. The carnivore community was more diverse in Ranthambhore (well-protected) than in the human disturbed habitats of Mukundara; however, the relative abundance of mesopredators was higher in Mukundara. Striped hyena density was estimated higher in Mukundara (40.6 ± 7.36/100 km^2) than in Ranthambhore (9.3 ± 1.3/100 km^2), while leopard density estimates were comparable (Mukundara, 10.9 ± 3.0/100 km^2; Ranthambhore, 11.2 ± 1.6/100 km^2). Temporal activities of carnivores in Mukundara indicated avoidance of

human disturbance, while in Ranthambhore, it seemed primarily governed by competitive interactions between carnivores. Our findings are indicative of the mesopredator release hypothesis, where the number of mesopredators increased in the absence of top predator; however, the results are confounded by differential resource availability, human disturbance, and poaching levels between sites. The outcomes emphasised the importance of conserving habitat fragments (irrespective of charismatic species' presence) in human-dominated landscapes to conserve carnivore populations. Conservation investments should focus on habitat protection, securing inviolate areas inside the PAs and restoring connectivity between PAs.

Makwana, M., Vasudeva, V., Cushman, S. A., and Krishnamurthy, R. (2023). Modelling landscape permeability for dispersal and colonization of tigers (Panthera tigris) in the Greater Panna Landscape, Central India. Landscape Ecology, 38(3), 797-819.

ABSTRACT

Context: Conservation approaches focussed within protected areas (PAs) have proved successful for tiger (Panthera tigris) conservation in India, but India's growing tiger population requires a landscape-level approach to ensure protection of both source populations and dispersing individuals. Thus, spatially explicit mapping of corridors to support existing metapopulations and provide opportunities for recolonization (i.e., stepping stones, satellite cores) are essential to guide conservation and management planning.

Objective: We aimed to model functional connectivity for dispersal and natural colonization of tigers in Central India, and validate our predictions using movement data of translocated tigers in the region.

Methods: We first mapped 28 forest patches in the Greater Panna Landscape (GPL) in Central India. Using a resistance surface, we modelled connectivity with least cost path analysis and circuit theory. Centrality scores and pinch-points were calculated, enabling identification of stepping stones and satellite cores. We validated the predicted corridors through spatial path randomization of independent tiger telemetry data. Results: We identified 67 corridor links, 10 stepping stones and 11 satellite cores. Validation confirmed high prediction accuracy, with empirical dispersal paths having mean connectivity values higher than 70% to 98% of the randomised paths.

Conclusion: Functional connectivity assessment in heterogeneous landscapes can benefit from deploying multiple connectivity methods and empirical validation. Our analysis identified corridors, stepping stones and satellite cores that were consistent between multiple connectivity

modelling methods and strongly reflected actual observed patterns of tiger dispersal in this landscape. These "consensus" areas provide useful insights for spatial planning for tiger conservation at landscape level.

Patel, S. K., Ruhela, S., Biswas, S., Pandav, B., and Mondol, S. (2023). The cost of sympatry: spatio-temporal patterns in leopard dietary and physiological responses to tiger competition gradient in Rajaji Tiger Reserve, Uttarakhand, India. Conservation Physiology, 11(1), coad039. *https://doi.org/10.1093/conphys/coad039*.

ABSTRACT

Apex predators have critical roles in maintaining the structure of ecosystem functioning by controlling intraguild subordinate populations. Such dominant–subordinate interactions involve agonistic interactions including direct or indirect impacts on the subordinates. As these indirect effects are often mediated through physiological processes, it is important to quantify such responses to better understand population parameters. We used a large carnivore intraguild system involving tiger (Panthera tigris) and leopard (Panthera pardus) to understand the dietary and physiological responses under a spatio-temporal gradient of tiger competition pressures in Rajaji Tiger Reserve (RTR) between 2015 and 2020. We conducted systematic faecal sampling in the winters of 2015 and 2020 from the park to assess diet and physiological measures. Analyses of leopard-confirmed faeces suggest a dietary-niche separation as a consequence of tiger competition. In 2020, we found an increased occurrence of large-bodied prey species without tiger competition in western-RTR. Physiological measures followed the dietary responses where leopards with large-sized prey in the diet showed higher fT3M and lower fGCM measures in western-RTR. In contrast, eastern-RTR leopards showed lower levels of fT3M and fGCM in 2020, possibly due to intense competition from tigers. Overall, these patterns strongly indicate a physiological cost of sympatry where competition with dominant tigers resulted in elevated nutritional stress. We recommend expansion of leopard monitoring and population estimation efforts to buffers, developing appropriate plans for human–leopard conflict mitigation and intensive efforts to understand leopard population dynamics patterns to ensure their persistence during the ongoing Anthropocene.

Tiwari, A., Tiwari, A., Saran, S., and Avishek, K. (2023). Assessment of Wildlife Connectivity inside a Protected Area Using Circuit Theory Approach.

ABSTRACT

Animal behaviour such as dispersal and migration ensure their survival in the landscape. It has been established in the past few decades that wildlife conservation and study of their movement

in the wilderness is vital for sustainable ecosystem. Thus, identification of regions having high movement permeability for planning and maintenance of functional wildlife corridors has turn out to be a fundamental requirement for habitat management. This study emphases on movement of big cats- Bengal Tiger (Panthera tigris tigris) and Leopard (Panthera pardus fusca) in the protected area of Rajaji National Park situated in Uttarakhand State of India. The National park is a designated tiger reserve with large amount of tigers and leopards at its disposal. Here, Circuitscape was used to generate connectivity map of the study area. The results were validated using occurrence points downloaded from GBIF. The habitat suitability and resistance of the landscape was estimated based on literature review and expert opinion survey. Since, both the species have comparable ecological niche, similar habitat parameters were used for generation of resistance map of the species. Occurrence points for the species were downloaded from GBIF. 60% of the points were used as nodes or focal points where species presence is recorded whereas 40% of the points were used in validation of the connectivity paths. Results depicts the current density map of the study area highlighting areas with high connectivity for the species.

MONITORING AND ASSESSMENT

DeFries, R., Parashar, S., Neelakantan, A., et al. (2023). Landscape Connectivity for Wildlife and Water: The State of the Literature. Current Landscape. Ecology Reports.
https://doi.org/10.1007/s40823-023-00091-0.

ABSTRACT

Purpose of Review: The science of landscape connectivity is widely applied to identify corridors for wildlife movement through unprotected areas. Where corridors coincide with forested or vegetated headwater catchments, they can contribute to blue water security for downstream users and recycle precipitation through green water flux to the larger region. This review examines the extent to which hydrology is recognized within studies on wildlife corridors. We illustrate the synergy between wildlife corridors and water security in the Central Indian Highlands, a globally important region for tiger (Panthera tigris) conservation and the water tower for five major rivers. Recent Findings: We find that a growing but still minor component of the literature on landscape connectivity addresses hydrology. Out of 127 publications on landscape connectivity that address both hydrology and wildlife, 50% were published after 2015 and hydrology-related words appear more frequently in abstracts over time (27% in 1993–2003 and 45% in 2014–2023 of most frequently used words) The case study illustrates potential synergies for water security and conservation, with areas for wildlife connectivity twice as rugged, three times more forested, and about 1.8 times denser with small streams than other areas in the landscape. About half of the area identified for landscape connectivity

overlaps with catchment areas for five major dams. Summary: Freshwater resources and water security are vital in human-dominated landscapes such as central India. A holistic view of landscape connectivity beyond wildlife provides practitioners with additional rationale for conserving these areas to maintain water resources that are directly relevant to people living in the landscape.

Nazareth, O., Srivathsa, A., and Ramachandran, V. (2023). Trunks and treetops: integrating terrestrial and arboreal camera-trap surveys to document elusive mammal communities in India. Mammalian Research. *https://doi.org/10.1007/s13364-023-00714-1*.

ABSTRACT

Tropical rainforest canopies harbor nearly half of the world's biodiversity. Previous research on rainforest ecosystems has primarily focused on the terrestrial stratum, leading to a limited understanding of forest canopies. Camera traps have seen a wide application in the studies of terrestrial mammals, but their utility for documenting arboreal mammal communities has been far more limited. Financial resources, field training, and access to equipment and logistical constraints may have precluded researchers from undertaking systematic arboreal camera surveys, especially in the Global South countries. We deployed arboreal and terrestrial cameras to document the mammal assemblage in Kadumane estate, Western Ghats, India. During April–May 2022, we documented 3 exclusively arboreal, 11 semi-arboreal and 14 terrestrial species, using 16 cameras in the canopies and 13 cameras on the ground. Using rarefaction curves, we find that 648 trap-nights were sufficient to document all the arboreal species, while > 1350 trap-nights of additional effort would have been required to document all the terrestrial species in our study site. For each species, we generated an arboreality index (calculated from proportional capture rates) to gauge its propensity for arboreal habits. We also compared the efficacy of using different baits; species responses to shrimp–dry fish baits indicated a reduction in rodent captures when carnivore captures were higher. Our study deliberates on the resources, logistical considerations, and advantages of arboreal camera surveys to study mammal assemblages in forest canopies. Importantly, we highlight the utility of such surveys for understanding the ecology of rare, elusive, and hitherto under-studied species that may be threatened with extinction.

Palei, N. C., Rath, B. P., Palei, H. S., and Mishra, A. K. (2023). Camera trap surveys reveal a wildlife haven: mammal communities in a tropical forest adjacent to a coal mining landscape in India. Journal of Threatened Taxa, 15(8), 23653-23661.

ASBTRACT

Having knowledge of the status and distribution of species in a specific geographic area is crucial for creating efficient conservation strategies. In this study, we evaluated the abundance and diversity of medium to large sized mammals in a tropical forest in India that has been greatly impacted by coal mining. Using camera traps between June 2018 and December 2018, we recorded 27 mammal species over 3432 trap-nights in 81 camera trap stations within the study area. The photo-captured species included both common and high conservation value threatened species, such as tiger Panthera tigris, leopard P. pardus, sloth bear Melursus ursinus, Asian elephant Elephas maximus, Gaur Bos gaurus, Indian pangolin Manis crassicaudata, and four-horned antelope Tetracerus quadricornis. Wild boar Sus scrofa was found to be the most frequently photo-captured and widespread species. Our study provides valuable data on the species inventory and the relative abundance of species in the area, highlighting its significance for mammal conservation. It also emphasizes the need for effective conservation management strategies to protect the remaining forest fragments containing high diversity of mammals, including several threatened species in India.

Qureshi, Q., Jhala, Y. V., Yadav, S. P., and Mallick, A. (2023). Status of Tigers Co-predators and Prey in India, 2022. Report. Wildlife Institute of India, Dehradun and National Tiger Conservation Authority, Government of India, New Delhi.

SUMMARY

In 1973, the Project Tiger was established with the objective of utilizing the tiger's functional role and charisma to garner public support and resources for preserving representative ecosystems. Since its inception, the project has expanded from nine tiger reserves covering 18,278 km^2 to 53 reserves covering 75,796 km^2, which account for 2.3% of India's land area. Despite this, most tiger reserves and protected areas in India are existing as small islands in a vast sea of ecologically unsustainable land use, and many tiger populations are confined to small protected areas. Although some habitat corridors exist that allow tiger movement between them, most of these habitats are not protected areas, continue to deteriorate further due to unsustainable human use and developmental projects, and thereby are not conducive to animal movement.

As tigers inhabit diverse habitats across a vast geographical expanse in India, we have categorized the tiger-bearing habitats into five major landscapes based on biogeography and interconnectivity of the habitats: 1) Shivalik-Gangetic plains, 2) Central India and Eastern Ghats, 3) Western Ghats, 4) North Eastern Hills and Brahmaputra Flood Plains, and 5) the Sundarbans. Each landscape is analyzed as a separate unit, since environmental and habitat covariates

differ in their relationship with tiger abundance in each of the landscapes. Additionally, landscapes are an ecologically holistic entity because they function as a biological unit wherein tiger populations can share common individuals, a common gene pool, and can potentially disperse between populations. Given the current focus of landscape scale management philosophy currently being adapted, and that tiger movement between landscapes is rare in modern times, this division makes ecological sense, especially for management inferences and implementation.

The conservation of tigers in India can be divided into two phases. The first phase starting in the 1970s, involved the enactment of the Wildlife Protection Act and the establishment of protected areas that helped conserve tigers and tropical forest ecosystems. The second phase began in the 2005-06, with the government adopting a landscape-level approach and implementing strict monitoring for tiger conservation. This resulted in an increase in the tiger population from 1,411 in 2006 to 2,967 in 2018. The past four cycles of tiger monitoring in India have resulted in major changes in policy and tiger population management. This has included the designation and notification of inviolate critical core and buffer areas of tiger reserves, identification and declaration of new tiger reserves, recognition of tiger landscapes and the importance of corridors, integrating tiger conservation with developmental activities, planning reintroduction and supplementation strategies for tigers and ungulates, and prioritizing conservation investments to target unique vulnerable gene pools. This exercise brought to the forefront scientific thinking in forest staff and use of technology ensured transparency in data collection and collation. These outcomes provide an opportunity to incorporate conservation objectives supported with sound science-based data in policy and decision-making for the benefit of society.

At the beginning of the first tiger monitoring exercise in 2006, India was divided into 100 km^2 grid, and since then, this sampling space has remained constant. Each grid was uniquely coded so that subsequent inferences can be compared on the same spatial scale and extent. The overall sampled space for Phase I remains constant; what changes within that is camera-trapped space vs. model-predicted space for the tiger population. The estimation exercise is carried out in three phases, Phase I entails data collection at beat scale by forest department staff across country covering 10146 grids (of 100 km^2) followed by Phase III where the sampling is done at 174 sites encompassing 32588 locations which resulted in 4,70,81,881

photographs having 97,399 tiger pictures. Phase II is done at Wildlife Institute of India which involves generating landscape level data using remote sensing and secondary data sources. Total man-days in data collection and collation was 6,41,102. This is the largest survey done so far.

The tiger occupancy has increased from 1758 cells of 100 km^2 in 2018 to 1792 in 2022. The unique tigers photographed in 2022 is 3080, while in 2018 there were 2461 unique tigers captured. The minimum estimated population is 3167. Population increase is substantial in Shivalik and Gangetic flood plain which is followed by Central India, North Eastern Hills and Brahmaputra flood plains and Sundarbans while Western Ghats population showed decline with major populations being stable.

The tiger population in the Forest Divisions of the Shivalik hills and Gangetic plains landscape has recorded substantial increase with total of 804 unique tigers being photographed, which is higher than estimated population of 646 (SE 567-726) in 2018. The photographic evidence of tigers in new areas in Uttar Pradesh and Himachal Pradesh provide hope of range expansion. To ensure their long-term survival, it is necessary to supplement and repopulate the Shivalik Forest Division of Uttar Pradesh and increase protection for tigers in Suhelwa, and pay special attention to the genetically divergent population of Valmiki. Linear infrastructure projects in the congested corridor between western and eastern Rajaji have left the area functionally extinct for large carnivores and elephant movement, and the adoption of green infrastructure is needed to recover the tiger population in this fragmented landscape. Additionally, Uttarakhand and Uttar Pradesh need to invest in mitigating conflicts with tigers and mega herbivores due to their increasing populations outside protected areas.

The Central Indian landscape has witnessed an increase in tiger population, with 1,161 unique tigers being photographed as compared to an estimated population of 1,033 (SE 885-1193) in 2018. Tigers have occupied new areas in Madhya Pradesh and Maharashtra. However, it is crucial to record that the local tiger population has become extinct in several areas, Sri Venkateswara National Park, including Tiger Reserves like Kawal, Satkosia and Sahyadri. While the expansion of tiger habitats is a positive development, there is a need to pay attention and act quickly in these areas to reverse the trend of extinction of small populations and avoid negative human-tiger interactions. Serious conservation efforts are needed to help tiger population recovery in Jharkhand, Odisha, Chhattisgarh, Telangana, and Andhra Pradesh. The small and genetically unique population of tigers in Simlipal is a priority for conservation. Wildlife habitats in the region face various threats, including habitat encroachment, illegal hunting, conflicts with humans, unregulated cattle grazing, excessive harvesting of non-timber forest products, forest fires, mining, and expanding infrastructure. Mitigation measures, such as eco-friendly construction techniques, lower mining impacts, and rehabilitation of mining sites, are essential to mitigate these threats. The construction of mitigation structures, such as the one on NH-44, is an example of a successful effort to mitigate the impact of infrastructure on wildlife habitats.

The protected areas within the Western Ghats are some of the most biodiverse in the country. However, the rise of development has led to an increasing overlap between wildlife and humans.

As of 2018, the tiger population was estimated at 981 (SE 871-1093) tigers in the region. In 2022, 824 unique tigers were recorded, indicating a decline in some regions and stability in well-protected tiger reserves. To safeguard the indigenous flora and the ecosystem as a whole, invasive species must also be contained. The Nilgiri cluster is home to the world's largest tiger population, but recent data shows a decrease in tiger occupancy throughout the Western Ghats, except in a few areas like Kali (Anshi Dandeli). While tiger populations within protected areas have either remained stable or increased, tiger occupancy outside of these regions has significantly decreased in areas, such as the Wayanad landscape, BRT Hills, and the border regions of Goa and Karnataka. The Mookambika-Sharavathi-Sirsi landscape and Bhadra have also experienced a substantial decline in tiger occupancy. Beyond the protected area border of Anamalai-Parambikulam complex, a decrease in tiger occupancy was also observed. Although tiger populations in the Periyar landscape have remained stable, tiger occupancy outside of Periyar has decreased. Local extinctions of tiger populations were noticed in Sirsi, Kanyakumari, and Srivilliputhur.

The landscape of North Eastern Hills and Brahmaputra is secure, with 194 distinctive tigers being captured on camera traps, with an estimated 219 (SE 194-244) tigers in 2018. The tiger population of North East is genetically unique and is small in size thus requiring intensive conservation efforts. The North East region of India holds immense ecological and cultural significance. Its unique wildlife species composition and high level of endemism make it ecologically important, coupled with its natural beauty and several indigenous communities. However, the region is currently facing several threats such as habitat loss, poaching, and human-wildlife conflict, which necessitate increased conservation efforts. The region is home to several tiger populations, and although various Tiger Reserves have been established, only Kaziranga and Manas have sizeable tiger populations. Tiger populations continue to be threatened, and more measures need to be implemented to address these threats, including fortifying protected area management, intensifying anti-poaching measures, involving local community to wean away from traditional hunting practices and tackling the underlying reasons for human-wildlife conflict.

The Sundarbans holds a unique and significant position for biodiversity conservation of mangrove ecosystem, and is situated near Kolkata. This region is susceptible to the effects of climate change and the rise of sea levels, which could cause submergence. The region undergoes yearly accretion and erosion, and it is surrounded by several forest villages that depend on its natural resources for sustenance. The Sundarbans tigers are well-suited to the mangrove ecosystem, but their habitat is confined. The tiger population and landscape are both threatened by biotic interference in the form of forest exploration, fishing, palm and timber extraction, and the expansion of waterways. To preserve the ecological integrity of the area, cross-border collaboration and knowledge exchange between India and Bangladesh

are imperative. In 2018, tiger population was estimated to be 88 (SE 86-90), whereas in 2022, images of 100 tigers were captured. The population is steady, with a limited potential to extend its range.

To ensure the long-term survival of tigers in India, a multi-faceted approach is needed, including protecting and expanding tiger habitats, preserving population connectivity, minimizing human-tiger conflicts, and combating threats like habitat loss, poaching, and illegal trade. It's important to restore habitats, increase ungulate populations, and plan reintroduction of tigers in low density areas to tackle conflict issues. The involvement of various stakeholders, such as governments, NGOs, local communities, and businesses, is crucial. Strategies like increased patrolling, monitoring, and law enforcement, focus on "Other Effective Area-based Conservation Measures (OECM)" along with promoting eco-tourism and sustainable livelihoods for local communities, can help achieve this goal.

The accomplishments achieved through Project Tiger are truly remarkable and unmatched worldwide. This is in part achieved due to our cultural traditions of believing we are one with nature – 'Vasudaiva kutambakam'. It is our duty to uphold this legacy and ensure that our conservation efforts don't go in vain, securing it for future generations by sustaining the progress we have made so far. We should strive to maintain our leadership position in global conservation efforts by setting the standards for ecosystem restoration while ensuring the progress of our developmental objectives and considering the well-being of all living beings – One Earth, One Family, One Future.

Yadav, S. P., Tiwari, V. R., Mallick, A., Garawad, R., Talukdar, G., Sultan, S., Ansari, N. A., Banerjee, K., and Das, A. (2023). Management Effectiveness Evaluation of Tiger Reserves in India, 2022 (Fifth Cycle), Summary Report. Wildlife Institute of India, Dehradun and National Tiger Conservation Authority, Government of India, New Delhi.

SUMMARY

India is a mega-biodiverse country, providing a home to 8% of the global biodiversity. In today's scenario, managing and conserving this biodiversity poses a serious challenge. The Government of India had launched the Project Tiger in 1973 to promote biodiversity conservation and conserve ecosystem functions, good and services using the charismatic tiger as a flagship. The initial number of 9 Tiger Reserves (TR) in the country in 1973 has crossed the mark of 50 in present times. The tiger reserve network in India has been acclaimed as the best conservation model worldwide providing excellent habitat for biodiversity conservation and human wellbeing. Not only that, they are also revered to a great extent for nature-based tourism because of their biological, natural and cultural values.

Survival of tigers is highly dependent on the success of the existing management and conservation initiatives. In order to measure the success of conservation efforts and maneuver management interventions, the effectiveness of management of tiger reserves needs to be ascertained. IUCN's World Commission on Protected Areas (WCPA) has provided a framework for assessing the management effectiveness of protected areas. The effectiveness is measured through six aspects: context, planning, input, process, output and outcomes. Under this framework, management is seen as a cycle with six different stages: i) establishing the context of existing values and threats, ii) progresses through planning, iii) allocation of resources (input), iv) result of management actions (process), v) produces goods and services (outputs) vi) all of which culminate in impacts or outcomes. Under this WCPA framework, an independent evaluation procedure was developed for India's tiger reserves. Management Effectiveness Evaluation (MEE) framework looks into the design issues, adequacy and appropriateness of management systems and the delivery of protected area objectives including conservation of values. Good management of protected areas depend on assessing the effectiveness of management and using the results as a tool for adaptive management. Such kind of assessments allow managers and stakeholders to ponder upon their experience, effective resource allocation and plan effective management strategies to deal with potential threats and opportunities. MEE also helps in promoting accountability and transparency, involving communities and building constituencies and promoting the values of protected areas.

India has effectively institutionalized the MEE process. Under the umbrella of Project Tiger, four consecutive cycles of evaluation of tiger reserves took place every four years over the period of 2006 to 2018 in India. 28 TRs were evaluated in 2006. The number increased to 39, 43, 50 and 51 in 2010, 2014, 2018 and 2022 respectively.

Till 2018, tiger reserves were rated as Very Good, Good, Satisfactory and Poor. In 2022, a new category, Excellent, was added. In 2022, a total of 12 tiger reserves have achieved 'Excellent' category, 21 tiger reserves achieved 'Very Good' category, 13 tiger reserves achieved 'Good' category and 5 tiger reserves attained 'Fair' category. Periyar Tiger Reserve, Kerala (MEE score 94.53%), Satpura Tiger Reserve, Madhya Pradesh and Bandipur Tiger Reserve, Karnataka (MEE score 93.18%) and Nagarhole Tiger Reserve, Karnataka (MEE score 92.42%) achieved the top three MEE score in 2022 cycle. The elements of 'Context' and 'Planning' scored maximum in this cycle whereas the element 'Input' received least attention by TRs and scored the least as well. Satpura TR (Madhya Pradesh), Simlipal TR (Odisha) were the top performers in terms of 'Context'. Pench TR (Maharashtra), BRT TR (Karnataka), Manas TR (Assam) were the top performers in terms of 'Planning'. Bhadra TR (Karnataka) scored highest in 'Input'. Satpura TR (Madhya Pradesh), Kanha TR (Madhya Pradesh) and Bandipur TR (Karnataka) scored maximum in 'Process'. Kanha TR (Madhya Pradesh), Nagarhole TR (Karnataka) and Periyar TR (Kerala) scored highest in 'Output' and Mudumala TR (Tamil Nadu) scored highest in 'Outcome'.

Yadav, S.P., Tiwari, V.R., Mallick, A., Garawad, R., Talukdar, G., Sultan, S., Ansari, N.A., Banerjee, K. and Das, A. 2023. Management Effectiveness Evaluation of Tiger Reserves in India, 2022 (Fifth Cycle), Summary Report. Wildlife Institute of India, Dehradun and National Tiger Conservation Authority, Government of India, New Delhi.

SUMMARY

India is a mega-biodiverse country, providing a home to 8% of the global biodiversity. In today's scenario, managing and conserving this biodiversity poses a serious challenge. The Government of India had launched the Project Tiger in 1973 to promote biodiversity conservation and conserve ecosystem functions, good and services using the charismatic tiger as a flagship. The initial number of 9 Tiger Reserves (TR) in the country in 1973 has crossed the mark of 50 in present times. The tiger reserve network in India has been acclaimed as the best conservation model worldwide providing excellent habitat for biodiversity conservation and human wellbeing. Not only that, they are also revered to a great extent for nature-based tourism because of their biological, natural and cultural values.

Survival of tigers is highly dependent on the success of the existing management and conservation initiatives. In order to measure the success of conservation efforts and maneuver management interventions, the effectiveness of management of tiger reserves needs to be ascertained. IUCN's World Commission on Protected Areas (WCPA) has provided a framework for assessing the management effectiveness of protected areas. The effectiveness is measured through six aspects: context, planning, input, process, output and outcomes. Under this framework, management is seen as a cycle with six different stages: i) establishing the context of existing values and threats, ii) progresses through planning, iii) allocation of resources (input), iv) result of management actions (process), v) produces goods and services (outputs) vi) all of which culminate in impacts or outcomes. Under this WCPA framework, an independent evaluation procedure was developed for India's tiger reserves. Management Effectiveness Evaluation (MEE) framework looks into the design issues, adequacy and appropriateness of management systems and the delivery of protected area objectives including conservation of values. Good management of protected areas depend on assessing the effectiveness of management and using the results as a tool for adaptive management. Such kind of assessments allow managers and stakeholders to ponder upon their experience, effective resource allocation and plan effective management strategies to deal with potential threats and opportunities. MEE also helps in promoting accountability and transparency, involving communities and building constituencies and promoting the values of protected areas.

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Till 2018, tiger reserves were rated as Very Good, Good, Satisfactory and Poor. In 2022, a new category, Excellent, was added. In 2022, a total of 12 tiger reserves have achieved 'Excellent' category, 21 tiger reserves achieved 'Very Good' category, 13 tiger reserves achieved 'Good' category and 5 tiger reserves attained 'Fair' category. Periyar Tiger Reserve, Kerala (MEE score 94.53%), Satpura Tiger Reserve, Madhya Pradesh and Bandipur Tiger Reserve, Karnataka (MEE score 93.18%) and Nagarhole Tiger Reserve, Karnataka (MEE score 92.42%) achieved the top three MEE score in 2022 cycle. The elements of 'Context' and 'Planning' scored maximum in this cycle whereas the element 'Input' received least attention by TRs and scored the least as well. Satpura TR (Madhya Pradesh), Simlipal TR (Odisha) were the top performers in terms of 'Context'. Pench TR (Maharashtra), BRT TR (Karnataka), Manas TR (Assam) were the top performers in terms of 'Planning'. Bhadra TR (Karnataka) scored highest in 'Input'. Satpura TR (Madhya Pradesh), Kanha TR (Madhya Pradesh) and Bandipur TR (Karnataka) scored maximum in 'Process'. Kanha TR (Madhya Pradesh), Nagarhole TR (Karnataka) and Periyar TR (Kerala) scored highest in 'Output' and Mudumala TR (Tamil Nadu) scored highest in 'Outcome'.

ZOOLOGY AND ANIMAL WELFARE

Jaya, M., Sandra, K. J., Aja, M., Prasanth, C. B., Brinesh, R., and Krishna, M. (2023). Prevalence and Distribution of Endoparasites in Carnivorous Primates from Thrissur Zoological Garden. Uttar Pradesh Journal of Zoology, 44(1), 56-66. 10.56557/upjoz/2023/v44i13391.

ABSTRACT

The animals selected for the endoparasitic observation are four species of carnivorous mammals specifically, Asiatic lion (Panthera leo persica), Bengal tiger (Panthera tigris tigris), Indian leopard (Panthera pardus fusca) and Indian jackal (Canis aureus indicus) that have been captivated in Thrissur Zoo. By using direct smear inspection, conventional sedimentation, and flotation procedures, the faecal samples were subjected to a thorough routine parasitological study to determine the presence of parasite eggs and oocysts. The current analysis revealed that helminth and protozoan parasites infest four species of carnivorous mammals. Ancylostoma, Toxascaris leonina, Toxocara, Strongyle type and the trematode eggs of the species of Paragonimus as well as the coccidian genera Isospora of protozoa, were all observed to be abundant in the gastro intestinal tract of chosen mammals as a result of the study. By statistical analysis, according to the most recent observations it is noticed thatToxocara makes upon 25% of wild mammals, and any of the parasites infects 60% of wild mammals.

Zachariah, A., Krishnankutty, S. P., Manazhi, J., Omanakuttan, V., Santhosh, S., Blanchard, A., and Tarlinton, R. (2023). Lack of detection of SARS-CoV-2 in Wildlife from Kerala, India in 2020-21. *https://doi.org/10.1099/acmi.0.000686.v1*

ABSTRACT

Spill over of SARs-CoV-2 into a variety of wild and domestic animals has been an ongoing feature of the human pandemic. The establishment of a new reservoir in white tailed deer in North America and increasing divergence of the viruses circulating in them from those circulating in the human population has highlighted the ongoing risk this poses for global health. Some parts of the world have seen more intensive monitoring of wildlife species for SARS-CoV-2 and related coronaviruses but there are still very large gaps in geographical and species-specific information. This paper reports negative results for SARS-CoV-2 PCR based testing using a pan coronavirus end point RDRP PCR and a Sarbecovirus specific E gene qPCR on lung and or gut tissue from wildlife from the Indian State of Kerala. These animals included: 121 Rhinolophus rouxii (Rufous Horsehoe Bat), 6 Rhinolophus bedommei (Lesser Woolly Horseshoe Bat), 15 Rossettus leschenaultii (Fulvous Fruit Bat), 47 Macaca radiata (Bonnet macaques), 35 Paradoxurus hermaphroditus (Common Palm Civet), 5 Viverricula indica (Small Indian Civet) , 4 Herpestes edwardsii (Common Mongoose), 10 Panthera tigris (Bengal Tiger), 8 Panthera pardus fusca (Indian Leopard), 4 Prionailurus bengalensis (Leopard cats), 2 Felis chaus (Jungle cats), 2 Cuon alpinus (Wild dogs) and 1 Melursus ursinus (sloth bear).

Simlipal TR / Yashpal Rathore

Camilla Malvestiti

INDONESIA

HUMAN WILDLIFE INTERACTION AND CONFLICT MITIGATION

Ekarini, D. F., Setiawati, S., and Gawi, J. M. (2023). Enabling sustainable community-based human-tiger conflict management in Seluma, Bengkulu, Indonesia. Biodiversitas Journal of Biological Diversity, 23(12), 6404-6412.

ABSTRACT

Enabling sustainable community-based human-tiger conflict management in Seluma, Bengkulu, Indonesia. Biodiversitas 23: 6404-6412. Human-wildlife conflict has emerged as one of the major threats to the global population of large carnivores. This condition applies to the endemic and Critically Endangered Sumatran tiger (Panthera tigris sumatrae). Although efforts to resolve conflict have been made from time to time, a sustainable solution is still very much needed, particularly given the unique characteristics of each case and area of conflict. A community-based approach to human-tiger conflict management can become a local-based solution towards a more sustainable management. This study aims to identify needs, gaps, and next steps related to collective action and sustainable community-based human-tiger conflict management in Seluma, Bengkulu, using a qualitative approach with literature review followed by semi-structure interview method. This study's findings show that in the context of community-based human-tiger conflict management, the needs and gaps are still identified, particularly in: training and capacity building, adaptive management and applied research, communication and information exchange, policy frameworks and legal instruments, as well as funding. To make community-based human-tiger conflict management sustainable, the strength and sustainability of: coherent legal instruments; commitment, involvement, active role, communication, and support from all stakeholders, and; comprehensive environmental, social and economic data-based planning; need to be ensured.

Figel, J. J., Safriansyah, R., Baabud, S. F., and Herman, Z. (2023). Clustered conflicts in disturbed lowlands characterize human–tiger interactions in Aceh, Indonesia. Wildlife Letters, 1(2), 83-91.

ABSTRACT

Conflict with humans is a severe threat to critically endangered Sumatran tigers Panthera tigris sumatrae. To better inform human-tiger conflict (HTC) management in Aceh, Sumatra, we analysed 96 cases of HTC reported to, and verified by, local government authorities between 2017 and 2021. Livestock depredation (49%) and people reporting fear or anxiety upon tiger

sightings (39%) comprised most incidents. We found significant differences in the frequency of HTC cases among land cover types in Aceh ($x2 = 160.4$, $df = 4$, $p < 0.001$). During our study period, oil palm plantations covered 9.5% of Aceh's land surface but represented the dominant habitat type in 46.9% of the province's HTC cases. By enabling a better understanding of landscape variables and patterns associated with HTC, this study will help to develop management strategies to advance tiger conservation and support rural livelihoods in Aceh, one of the last remaining Sumatran tiger strongholds.

Patana, P., Alikodra, H. S., Mawengkang, H., and Harahap, R. H. (2023). State of human tiger conflict around Gunung Leuser National Park in Langkat Landscape, North Sumatra, Indonesia. Biodiversitas Journal of Biological Diversity, 24(2), 837-846. DOI: 10.13057/biodiv/d240220.

ABSTRACT

State of human tiger conflict around Gunung Leuser National Park in Langkat Landscape, North Sumatra, Indonesia. Biodiversitas 24: 837-846. The Sumatran tiger (Panthera tigris sumatrae) is one of the key species which is considered an endangered species by the IUCN (2008). There has also been a recent threat to their population due to conflict with humans. Information about landscape characteristics and livelihood related to human-tiger conflict (HTC) is needed for a proper mitigation strategy based on local parameters. Therefore, this study was carried out around Gunung Leuser National Park (GLNP) using quantitative and qualitative methods. Principal component analysis (PCA) was used to analyze and map the risk of HTC using landscape characteristics. The physical factors, including land cover, slope, elevation, distance from rivers, and settlement, were analyzed. The livelihood aspect related to land use change was described descriptively and became a major analysis. The study area is located in the buffer zone of GLNP in Langkat District. The results showed that the Eigen weight value for the slope, elevation, and land cover factor was greater than the distance to the river and settlement. The spatial analysis also revealed that Langkat Landscape was in the medium risk of HTC by covering 60% area, while 40% was in the interval of high to very high risk. Furthermore, the high dependence on land for agriculture and the activity of livestock has become a trigger for more massive HTC in the last three years. It is a challenge in human-tiger conflict mitigation to involve the resolution of people's livelihoods surrounding the national park. The livelihood approach could be a future solution that bridges human and tiger aspects, in addition to habitat management and protecting conservation areas.

CONSERVATION, MANAGEMENT AND POLICY RECOMMENDATION

Withaningsih, S., Wiratno, Hadi, A., Supriatna, J., and Nasrudin, A. (2023). Identifying Appropriate Surrogate for Gunung Leuser Priority Species by Using their Characters and Distributions: A Review. IOP Conference Series: Earth and Environmental Science, 1211, 012017.

ABSTRACT

Gunung Leuser National Park (GLNP) priority species is a surrogate species representing four wildlife, Panthera tigris sumatrae, Dicerorhinus sumatrensis, Elephas maximus sumatrensis, and Pongo abelii living within GLNP. GLNP priority species was appointed based on the extinction status, endemicity, population and habitat conditions, threat, and regional representation of wildlife. “GLNP priority species” terminology was considered from flagship species, keystone species, umbrella species, or charismatic species. This literature review aimed to clarify the appropriateness of GLNP priority species to other surrogates by comparing the characters and distributions of GLNP priority species to the definition of surrogate species. This review identified five surrogate species: key-stone species, indicator species, umbrella species, flagship species, and charismatic species. GLNP priority species are appropriate to be GLNP flagship species based on two considerations: (1) the characters of all GLNP priority species which are endemic wildlife of Sumatera and are critically endangered based on the International Union for Conservation of Natures' status and (2) the condition of the priority species distributions which periodically decreased (elephant and rhino) and are threatened (tiger and orangutan). Besides, tiger and orangutan also can be determined as umbrella species considering their distribution spreads which are extensively covering the GLNP area.

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Habitat Ecology

Pudyatmoko, S., Budiman, A., and Siregar, A. H. (2023). Habitat suitability of a peatland landscape for tiger translocation on Kampar Peninsula, Sumatra, Indonesia. Mammalian Biology, 103(4), 375-388.

ABSTRACT

The risk of large carnivore mortality from anthropogenic sources is increased in areas where frequent human-carnivore encounters are high. Translocation is a potential tool for reducing these conflicts and re-establishing wild populations. Determining proper translocation sites for tigers is important for securing their future. In this research, we quantitatively evaluated

the habitat suitability of a potential tiger translocation area on the Kampar Peninsula, a large peatland landscape in Sumatra. This landscape is essential for the conservation of the local tiger population, but its role as a tiger habitat has rarely been investigated. We conducted this research in a region with mosaicked land-use types covering an area of 7,045.89 km^2. We applied species ecological niche factor analysis (ENFA) to model habitat suitability using species presence and ecogeographical variables as the bases. The model predicted that approximately 60% of the study area is tiger-suitable habitat with varying suitability levels. The tiger habitat characteristics in the study region are dissimilar to the global tiger habitat characteristics, and the high specialization value obtained indicates that tigers inhabit very narrow niches. Considering the low density of tigers in peatlands, we estimate that the carrying capacity of the whole Kampar landscape is approximately 13 tigers. Therefore, to conserve a viable tiger population, it is necessary to maintain connectivity between the Kampar peatlands and the Kerumutan landscape situated to the south of the Kampar Peninsula.

Behaviour

Kiranaputri, G., Sjahfirdi, L., Tumbelaka, L. I. T. A., Priyanto, S. K., Yana, A., Yuliati, L. C., Risgianto, N., Mukti, G. W., Herawati, M. E., and Firmansyah, A. B. (2023). Effects of Fresh Chicken Meat and Wood Enrichments on Behavior of Sumatran Tigers (Panthera tigris sumatrae, Pocock, 1929) at Tambling Wildlife Nature Conservation Rescue Centre. IOP Conference Series: Earth and Environmental Science, 1174, 012008.

ASBTRACT

Behavior gives valuable information for tiger's management care. Tigers may perform stereotypic behavior as coping mechanism or stress in captivity. Enrichment techniques can reduce those stereotypic behavior. This research aims to evaluate food and environmental enrichment techniques on Sumatran tiger. Four tigers were observed by focal animal sampling (from 08.00 a.m. to 12.00 a.m. and 01.00 p.m. to 05.00 p.m.) at Tambling Wildlife Nature Conservation Rescue Centre. Tiger's behaviors were categorized into active, inactive and stereotypic. Two tigers (1 female and 1 male) were observed for 2 days each baseline and post-enrichment. Two tigers (both males) were observed for 4 days each baseline and post-enrichment. Novel woods were introduced to the tigers' enclosures for environmental enrichment. Fresh chicken meats (2 – 5 kg) were given disorderly at tigers' enclosures as food enrichment. Baseline and post-enrichment behaviors were analzyed with Wilcoxon. The outcome was tigers' stereotypic behavior (Z = -1,461, P = 0,144 > 0,05), active behavior (Z = -1,826, P = 0,680 > 0,05) and inactive behavior (Z = -1,095, P = 273 > 0,05) were not significantly reduced by these enrichment techniques. Other enrichment techniques need to be explored even more for tigers' management care.

GENETICS

Asrori, I., Tjong, D. H., Novarino, W., Mansyurdin, M., Syaifullah, S., and Roesma, D. I. (2023). DNA primer design for sex identification of Sumatran tiger body samples. Biodiversitas Journal of Biological Diversity, 24(1), 241-249.

ABSTRACT

Nowadays, forensic and wildlife research, especially the Sumatran tiger needs further research with a molecular approach. Molecular approaches are needed for forensic and wildlife research including for sex identity. This study used the amelogenin gene as a marker for identification based on previous studies of Felidae species. The sample used consisted of 10 blood samples from Sumatran tigers of known sex were collected by the Dharmasraya Sumatran Tiger Rehabilitation Center (PRHSD), one hair sample, and two bone samples whose sex was unknown were collected from Natural Resources Conservation Center West Sumatra (BKSDA). The PCR results of the amelogenin gene of the Sumatran tiger confirmed the sex of 10 samples of known sex's Sumatran tiger (Four male samples and six female samples), and Three samples of unknown sex were identified as females. Male was characterized by the electrophoresis appearance of two bands, while in female's only one band, with PCR product sizes of at least 190 bp for AMELY and at least 210 bp for AMELX.

Andayani, N., Maryanto, A. E., and Nur, M. N. (2023). Development of DNA Extraction Method for Forensics Studies of Preserved Hair and Skin Samples from Sumatran Tiger (Panthera tigris sumatrae, Pocock 1929). HAYATI Journal of Biosciences, 30(5), 816-824.

ABSTRACT

Poaching and illegal wildlife trade present severe threats to the Sumatran tiger. The high demand for tiger body parts leads to a high number of imitations in illegal markets, complicating the morphological identification of any confiscation cases. Accurate identification is essential in legal due process, given that the national protection law only regulates Indonesia's native species. Identification using molecular approaches may overcome the problem. However, most illegally traded tiger body parts have been preserved for an extended period of time, reducing the quantity and quality of the recovered DNA. This study aimed to develop a fast and effective method to recover DNA from preserved forensic samples. The methods had been tested with several museum samples of arsenic-treated hairs and a tiger skin piece obtained from the National Research and Innovation Agency (BRIN, formerly LIPI), tiger hairs obtained from Conservation of Natural Resources Agency (BKSDA) of Bengkulu Province, and a confiscated tiger skin sample from BKSDA Aceh. The DNA was extracted using ion-exchange, salting

out, and protease-based methods. The results showed that the protease-based extraction outperformed the others to yield applicable DNA isolates for PCR-based species identification by Cyt b and ND2 mtDNA partial genes from preserved samples. However, further works are still needed to recover sufficient DNA yields for sex identification.

ZOOLOGY AND ANIMAL WELFARE

Amarilis, K., Suandika, P., Ahmadi, M., Sianipar, D. H. A., Windarti, Nurcahyo, R. W., and Indarjulianto, S. (2023). Retrospective Study of Helminthiasis in Wild Sumatran Tiger (Panthera tigris sumatrae) Rescued by Dharmasraya Sumatran Tiger Rehabilitation Center. IOP Conference Series: Earth and Environmental Science, 1174, 012026.

ABSTRACT

This study aims to determine the incidence of worm infection in wild Panthera tigris sumatrae rescued at Dharmasraya Sumatran Tiger Rehabilitation Center ARSARI based on physical and laboratory examination. The study used 12 Sumatran tigers, immediately after the tigers had been rescued. All Sumatran tigers were physically examined, followed by checking their blood and fecal for investigating the possibility of helminthiasis infections. The fecal examination method was carried out using qualitative methods (native, sedimentation, and flotation). The results of the physical examination found that 5 tigers didn't show any clinical symptoms and 7 tigers were anemic and dehydrated with their blood profiles showing the presence of eosinophilia. The results also found that there were five types of worm eggs, namely Ancylostoma sp . (75%), Toxocara sp . (25%), Trichuris sp . (25%), Strongyloides sp . (8.3%) and Trichostrongylus sp . (8.3%) with a 100% helminthiasis incidence. These results of this retrospective study are expected to provide information on helminthiasis infection in wild P.t. sumatrae in their natural habitat. In conclusion, all of 12 rescued tigers suffering from helminthiasis with the main clinical symptoms being anemia, dehydration and eosinophilia.

MALAYSIA

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Holland, A., Galardi, E. G., Fabbroni, M., Hashmi, A., Catinaud, J., Preziosi, R., Brereton, J. E., and Pastorino, G. Q. (2023). Exploration of Social Proximity and Behavior in Captive Malayan Tigers and Their Cubs. Animals, 13(6), 1040-1040.

ABSTRACT

The survival of endangered felids is becoming increasingly dependent on the successful management and breeding of reserve populations in captivity. While most felid species are reported to be solitary in the wild, increasing evidence suggests that some big cats have greater social plasticity than is currently acknowledged. This social plasticity allows felids to be sometimes socially housed in environments such as zoos and rescue centers. While the effects of such shared enclosures remain in question, many reports provide evidence of several welfare benefits of maintaining these large carnivores in pairs or even groups. Since 2019, Le Parc des Félins has housed a breeding pair of Malaysian tigers (Panthera tigris jacksoni) alongside their offspring. The purpose of this study was to quantify the social affiliation between the male tiger and his cubs and to investigate the female's tolerance toward him. The data were collected using video recordings in the outdoor enclosure when social interactions were observed. The data were coded and categorized in the open-source software BORIS, from which behavioral activity budgets were calculated. Data were analyzed using the chi-squared test for association to determine differences in affiliative frequency, with directed and undirected sociograms created to visualize individual relationships. Overall, the male regularly engaged in affiliative behaviors with the cubs, with no significant difference found in the frequency of interactions with them compared to the female. No physical aggression was directed by the male toward the cubs. Although the female maintained a stronger bond with the cubs compared to the male, he displayed a greater range of affiliative behaviors toward them than male tigers are thought to exhibit. Both adults showed a high degree of tolerance toward their conspecifics, suggesting that maintaining breeding pairs with their offspring is a viable management strategy in zoological collections. This study could therefore improve husbandry and conservation practices by developing our understanding of felid sociality and the potential welfare benefits of social housing, allowing for evidence-based captive management decisions.

ZOOLOGY AND ANIMAL WELFARE

Jeffrey, A., Artzer, M., Gardhouse, S., Sarvi, J., McHaney, A., Bell, C., and Winter, D. (2023). Keratinized Odontogenic Cysts in a Malayan Tiger (Panthera tigris jacksoni). Journal of veterinary dentistry, 8987564231184112. Advance online publication. *https://doi.org/10.1177/08987564231184112*

ABSTRACT

A 14-year-old male intact Malayan tiger (Panthera tigris jacksoni) was presented for a routine annual wellness exam and comprehensive oral health assessment and treatment, during which an odontogenic cyst was incidentally diagnosed from radiographs. Prior to a second immobilization for computed tomography (CT) and surgical removal of the cyst, the tiger developed anorexia, lethargy, and reluctance to train, which were clinical signs suspected to be reflective of pain secondary to the odontogenic cyst. A CT scan of the skull revealed 2 odontogenic cyst lesions associated with teeth 204-207 and 208-209, and associated tooth root resorption, focal lysis of the maxilla, communication with the left nasal passage, thinning of the ventral margin of the left orbit and maxillary foramen, and left mandibular lymphadenopathy. Complete enucleation of each cyst wall and surgical extraction of associated teeth were performed. Histopathologic findings were consistent with an odontogenic cyst containing keratinized stratified squamous epithelium, keratin debris within the cyst lumen, and a lymphoplasmacytic inflammatory infiltrate. Postoperatively, the tiger recovered uneventfully, clinical signs resolved within 2 weeks and have not recurred at the time of publication of this article. Similar keratinized odontogenic cysts are described in dogs, and there is only one other case report in a felid. This is the first known report of an odontogenic cyst in a tiger and of a keratinized odontogenic cyst in a nondomestic species.

Khairulmunir, M., Gani, M., Karuppannan, K. V., Mohd-Ridwan, A. R., and Md-Zain, B. M. (2023). High-throughput DNA metabarcoding for determining the gut microbiome of captive critically endangered Malayan tiger (Panthera tigris jacksoni) during fasting. Biodiversity Data Journal, 11, e104757. *https://doi.org/10.3897/BDJ.11.e104757*

ABSTRACT

The Malayan tiger (Panthera tigris jacksoni) is a critically endangered species native to the Malaysian Peninsula. To imitate wild conditions where tigers do not hunt every day, numerous wildlife sanctuaries do not feed their tigers daily. However, the effects of fasting on the gut microbiota of captive Malayan tigers remains unknown. This study aimed to characterise the gut microbiota of captive Malayan tigers by comparing their microbial communities during fasting versus normal feeding conditions. This study was conducted at the Melaka Zoo, Malaysian Peninsula and involved Malayan tigers fasted every Monday. In total, ten faecal samples of Malayan tiger, two of Bengal tiger (outgroup) and four of lion (outgroup) were collected and analysed for metabarcoding targeting the 16S rRNA V3–V4 region. In total, we determined 14 phyla, 87 families, 167 genera and 53 species of gut microbiome across Malayan tiger samples. The potentially harmful bacterial genera found in this study included Fusobacterium , Bacteroides , Clostridium sensu stricto 1, Solobacterium , Echerichia shigella , Ignatzschineria and Negativibacillus . The microbiome in the fasting phase had a higher composition and was more diverse than in the feeding phase. The present findings indicate a balanced ratio in the dominant phyla, reflecting a resetting of the imbalanced gut microbiota due to fasting. These findings can help authorities in how to best maintain and improve the husbandry and health of Malayan tigers in captivity and be used for monitoring in ex-situ veterinary care unit.

Shibu Nair

MYANMAR

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Naing, H., Fuller, T. K., Sievert, P. R., Randhir, T. O., Tha Po, S. H., Htun, S., and Myint, T. (2023). Dry-season habitat occupancy by ungulate tiger prey in the Hukaung Valley of northern Myanmar. Tropical Zoology, 36(1-2), 21-35. doi:10.4081/tz.2023.124.

ABSTRACT

We assessed habitat occupancy and distribution of principal tiger (Panthera tigris) ungulate prey species to assess factors affecting their occurrence and their potential contribution to low tiger presence in the core part of the Hukaung Valley Wildlife Sanctuary, in northern Myanmar. We surveyed for signs on 1,651 km of transects partitioned into 554 sampling units between November 2007 and May 2008. By incorporating seven environmental and four social covariates, we predicted habitat occupancy rates of 0.76 for gaur (Bos gaurus), 0.91 for sambar (Rusa unicolor), 0.57 for wild pigs (Sus scrofa), and 0.89 for northern red muntjac (Muntiacus vaginalis). Overall, shorter Euclidean distances to ranger stations and trails, decreased stream density, and broadleaved evergreen/semi-deciduous forest and relatively rare rain-fed cropland habitat occurrence positively influenced prey habitat occupancy; conversely, shorter Euclidean distances to villages, roads, and streams, higher elevations, and occurrence of mixed broadleaved and needle-leaved forest habitat negatively influenced occupancy. In addition, Euclidean distance to ranger stations, trails, and roads positively affected species detections, whereas shorter Euclidean distance to villages and streams, high elevations, and high precipitation negatively affected detections. Results indicated that all four prey species were relatively well-distributed through the Sanctuary core area, but comparisons with indices of abundance elsewhere suggest that prey density was low and would not likely support many tigers.

NEPAL

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Bhatt, T. R., Castley, J. G., Sims-Castley, R., Baral, H. S., and Chauvenet, A. L. M. (2023). Connecting tiger (Panthera tigris) populations in Nepal: Identification of corridors among tiger-bearing protected areas. Ecology and Evolution, 13(5), e10140.

ABSTRACT

Habitat fragmentation and isolation threaten the survival of several wide-ranging species, such as tigers, through increased risk from diseases, disasters, climate change, and genetic depression. Identification of the habitat most likely to achieve connectivity among protected areas is vital for the long-term persistence of tigers. We aimed to improve the mapping of potential transfrontier protected area corridors for tigers by connecting sites within the Terai Arc Landscape in Nepal and to those in India, highlighting targeted conservation actions needed along these corridors to maintain long-term connectivity. We used least-cost corridor modeling and circuit theory to identify potential corridors and bottlenecks in the study area. The landscape's resistance to tigers' movement was gathered from expert opinions to inform corridor modeling. We identified nine potential tiger corridors in the Terai Arc Landscape-Nepal that aligned strongly with the remaining intact habitats of the Siwalik landscape, which could facilitate tiger movement. Banke-Bardia and Chitwan-Parsa-Valimiki complexes and Lagga-Bhagga and Khata corridors were identified as high-priority conservation cores and corridors. While our model exhibited congruence with most established corridors in the landscape, it has identified the need to enhance existing corridors to improve landscape connectivity. Several pinch points posing an increased risk to connectivity were identified. Most of these were located near the protected area boundaries and along the Nepal-India border. The Siwalik landscape holds the key to long-term connectivity in the study area; however, immediate conservation attention is needed, particularly at pinch points, to secure this connectivity for tigers. Validation of identified corridors through empirical research and their conservation is a priority.

Behaviour

Carter, N. H., Zuckerwise, A., Pradhan, N. M. B., Subedi, N., Lamichhane, B. R., Hengaju, K. D., Acharya, H. B., and Kandel, R. C. (2023). Rapid behavioral responses of endangered tigers to major roads during COVID-19 lockdown. Global Ecology and Conservation, 42, e02388. *https://doi.org/10.1016/j.gecco.2023.e02388*.

ABSTRACT

Roads pose a major, and growing, challenge for the conservation of endangered species. However, very little is known about how endangered species behaviorally respond to roads and what that means for road mitigation strategies. We used the nation-wide lockdown in Nepal during the COVID-19 pandemic as a natural experiment to investigate how dramatic reductions in traffic volume along the national highway affected movements of two GPS-collared tigers (Panthera tigris)—a globally endangered species. This work is the first systematic research on tigers in Nepal using radiotelemetry or GPS tracking data since the 1980s. We found that the highway more strongly constrained the space use and habitat selection of the male in Parsa National Park than the female in Bardia National Park. Over the entire study period, the female on average crossed 10 times more often per week than the male, and when he was near the highway, he was over 11 times more probable to not cross it than to cross during the day. However, we also found that the cessation of traffic during the pandemic lockdown relaxed tiger avoidance of roads and made the highway more permeable for both animals. They were 2–3 times more probable to cross the highway during the lockdown than before the lockdown. In the month following the lockdown, the space use area of the male tiger tripled in size (160–550 km^2), whereas the female's shrunk to half its previous size (33–15 km^2). These divergent patterns likely reflect differences between the two parks in their highway traffic volumes and regulations as well as ecological conditions. Our results provide clear evidence that vehicle traffic on major roads impede tiger movements, but also that tigers can respond quickly to reductions in human pressures. We conclude by identifying various actions to mitigate road impacts on tigers and other endangered species.

CONSERVATION AND MANAGEMENT, POLICY RECOMMENDATIONS

Al Faisal, A., Al Kafy, A., Afroz, F., and Rahaman, Z. A. (2023). Exploring and forecasting spatial and temporal patterns of fire hazard risk in Nepal's tiger conservation zones. Ecological Modelling, 476, 110244. DOI: 10.1016/j.ecolmodel.2022.110244.

ABSTRACT

Forest fires are the leading cause of deforestation. In March, April, and May, which are the three driest months of the year, 89% of all forest fires in Nepal are caused by humans. Due to its diverse topography, climate, and sociodemographic interactions, the region is extremely vulnerable. The study aimed to investigate and forecast the spatiotemporal pattern of forest fires using space-time cube forecasting models and develop a tiger habitat suitability model based on space-time hotspots, trends, environmental, geomorphological, and human components. MODIS fire hazards data in vector point format from NASA's Terra and Aqua satellites between the years 2000 and 2020 were utilized as the primary dataset for this investigation. Fire hazards from 2000 to 2013 were utilized to analyze the spatiotemporal hot-cold spots trend, hotspot zone in 2D and 3D. Then fire hazards from 2014 to 2020 were forecasted and validated with raw datasets using the space-time exponential-smoothing and forest-based forecasting models. Results indicate that almost 52.77% and 69.05% of the total tiger habitat area were respectively in hotspot and uptrend zones. Only 0.3% of the entire tiger habitat area was identified in a cold-spot zone. Multi-Criteria Evaluation (MCE) suitability analysis estimated that the areas of Mahakal and Seti in the west and the top of Mechi in the east were found to be moderately suitable for tiger habitat. When compared to the exponential smoothing method (8.40%), the forest-based method produced a lower average inaccuracy of 8.29%, with mean RMSEs of 0.43 and 0.31, respectively. Overall, the study revealed a new era of technological spatiotemporal data utilization for fire hazard incidents, which could be used to identify suitable or vulnerable locations through space-time analysis and forecasting techniques.

Dahal, B. R., Amin, R., Lamichhane, B. R., Giri, S. R., Acharya, H., Acharya, H. R., and Harihar, A. (2023). Setting recovery targets for a charismatic species in an iconic protected area complex: The case of tigers (Panthera tigris) in Chitwan–Parsa National Parks, Nepal. Conservation Science and Practice, 5(6), 1-8.

ABSTRACT

The Global Tiger Recovery Program has identified enhancing prey populations as a crucial component in achieving its target of doubling wild tiger (Panthera tigris) numbers, as prey density is a key determinant of tiger density. We estimate prey abundance and ecological carrying capacity (ECC) of tigers in the 1579 km 2 Chitwan-Parsa source site complex within a globally significant tiger conservation landscape in south-central Nepal. Surveying 605.1 km of line transects in the Terai plains and Chure hills of Chitwan-Parsa, we estimated an overall density of 55.43 (36.98-83.45) ungulates/km 2 , and a biomass of 244,630 (151,520-334,270) kg/100 km 2 of five abundant ungulates. Chitwan supports 71.58 (49.02-104.71) and Parsa 30.91 (18.70-51.19) ungulates/km 2. The prey base can support 177 (119-263) adult tigers based on energetic requirement models. The tiger ECC was $3.5Â higher in Chitwan than in Parsa at a park level. Although opportunities for further recovery of tiger and prey through targeted habitat management exist, the current population of 170 tigers indicates that this population has likely reached its current ECC. We recommend that policymakers and park managers change focus from increasing tiger numbers to developing pre-emptive conflict mitigation strategies to allow the site to retain the successes it has realized.

MONITORING AND ASSESSMENT

Bijlmakers, J., Griffioen, J., and Karssenberg, D. (2023). Environmental drivers of spatio-temporal dynamics in floodplain vegetation: grasslands as habitat for megafauna in Bardia National Park (Nepal). Biogeosciences, 20(6), 1113-1144.

ABSTRACT

Disturbance-dependent grasslands, often associated with hydromorphological and fire dynamics, are threatened, especially in subtropical climates. In the Nepalese and Indian Terai Arc Landscape at the foot of the Himalayas, natural and cultural grasslands serve a viable role for greater one-horned rhinoceros (Rhinoceros unicornis) and for grazers that form prey of the Royal Bengal tiger (Panthera tigris). The grasslands are vulnerable to encroachment of forest. We aimed to establish the effects of environmental drivers, in particular river discharge, river channel dynamics, precipitation and forest fires, on the spatio-temporal dynamics of these grasslands. The study area is the floodplain of the eastern branch of the Karnali River and adjacent western part of Bardia National Park. We created annual time series (1993–2019) of land cover with the use of field data, remotely sensed LANDSAT imagery and a supervised classification model. Additionally, we analysed the pattern of grassland patches and aerial photographs of 1964. Between 1964 and 2019, grassland patches decreased in abundance and size due to encroachment of forest. Outside the floodplain, conversion of grassland to bare substrate coincides with extreme precipitation events. Within the floodplain, conversion of grassland to bare substrate correlates with the magnitude of the annual peak discharge of the bifurcated Karnali River. Since 2009, however, this correlation is absent due to a shift of the main discharge channel to the western branch of the Karnali River. Consequently, alluvial tall grasslands (Saccharum spontaneum dominant) have vastly expanded between 2009 and 2019. Because the hydromorphological processes in the floodplain have become more static, other sources of disturbances – local flooding of ephemeral streams, anthropogenic maintenance, grazing and fires – are more paramount to prevent encroachment of grasslands. Altogether, our findings underscore that a change in the environmental drivers impact the surface area and heterogeneity of grassland patches in the landscape, which can lead to cascading effects for the grassland-dependent megafauna.

ZOOLOGY AND ANIMAL WELFARE

Bodgener, J., Sadaula, A., Thapa, P. J., Shrestha, B. K., Gairhe, K. P., Subedi, S., Rijal, K. R., Pandey, P., Joshi, J. D., Kandel, P., Lamichane, B. R., Pokheral, C. P., Subedi, N., Kandel, R. C., Luitel, H., Techakriengkrai, N., and Gilbert, M. (2023). Canine Distemper Virus in Tigers (Panthera tigris) and Leopards (P. pardus) in Nepal. Pathogens (Basel, Switzerland), 12(2), 203.

ASBTRACT

From wild dogs (Lycaon pictus) in the Serengeti to tigers (Panthera tigris altaica) in the Russian Far East, canine distemper virus (CDV) has been repeatedly identified as a threat to wild carnivores. Between 2020 and 2022, six Indian leopards (P. pardus fusca) presented to Nepali authorities with fatal neurological disease, consistent with CDV. Here, we report the findings of a serosurvey of wild felids from Nepal. A total of 48 serum samples were tested, comprising 28 Bengal tigers (P. t. tigris) and 20 Indian leopards. Neutralizing antibodies were identified in three tigers and six leopards, equating to seroprevalences of 11% (CI: 2.8–29.3%, n = 28) and 30% (CI: 12.8–54.3%, n = 20), respectively. More than one-third of seropositive animals were symptomatic, and three died within a week of being sampled. The predation of domestic dogs (Canis lupus familiaris) has been posited as a potential route of infection. A comparison of existing diet studies revealed that while leopards in Nepal frequently predate on dogs, tigers do not, potentially supporting this hypothesis. However, further work, including molecular analyses, would be needed to confirm this.

Sudhir Mishra

RUSSIA

ZOOLOGY AND ANIMAL WELFARE

Zoelzer, F., Schneider, S., and Dierkes, P. W. (2023). Time series cluster analysis reveals individual assignment of microbiota in captive tiger (Panthera tigris) and wildebeest (Connochaetes taurinus). Ecology and Evolution, 13(5), e10066.

ABSTRACT

Fecal microbiota variability and individuality are well studied in humans and also in farm animals (related to diet- or disease-specific influences), but very little is known for exotic zoo-housed animals. This includes a wide range of species that differ greatly in microbiota composition and variation. For example, herbivorous species show a very similar and constant fecal microbiota over time, whereas carnivorous species appear to be highly variable in fecal microbial diversity and composition. Our objective was to determine whether species-specific and individual-specific clustering patterns were observed in the fecal microbiota of wildebeest (Connochaetes taurinus) and tigers (Panthera tigris). We collected 95 fecal samples of 11 animal individuals that were each sampled over eight consecutive days and analyzed those with Illumina MiSeq sequencing of the V3–V4 region of the 16SrRNA gene. In order to identify species or individual clusters, we applied two different agglomerative hierarchical clustering algorithms – a community detection algorithm and Ward's linkage. Our results showed that both, species-specific and individual-specific clustering is possible, but more reliable results were achieved when applying dynamic time warping which finds the optimal alignment between different time series. Furthermore, the bacterial families that distinguish individuals from each other in both species included daily occurring core bacteria (e.g., Acidaminococcaceae in wildebeests or Clostridiaceae in tigers) as well as individual dependent and more fluctuating bacterial families. Our results suggest that while it is necessary to consider multiple consecutive samples per individual, it is then possible to characterize individual abundance patterns in fecal microbiota in both herbivorous and carnivorous species. This would allow establishing individual microbiota profiles of animals housed in zoos, which is a basic prerequisite to quickly detect deviations and use microbiome analysis as a non-invasive and cost-effective tool in animal welfare.

THAILAND

BIOLOGY, ECOLOGY AND NATURAL HISTORY

Ash, E., Cushman, S., Kaszta, Ż., Landguth, E., Redford, T., and Macdonald, D. W. (2023). Female-biased introductions produce higher predicted population size and genetic diversity in simulations of a small, isolated tiger (Panthera tigris) population. Scientific Reports, 13(1), 11199.

ABSTRACT

Isolation of wildlife populations represents a key conservation challenge in the twenty-first century. This may necessitate consideration of translocations to ensure population viability. We investigated the potential population and genetic trajectory of a small, isolated tiger (Panthera tigris) population in Thailand's Dong Phayayen-Khao Yai forest complex across a range of scenarios. Using an individual-based, spatially-explicit population modelling approach, we simulate population and genetic trajectories and evaluate the relative impact of translocations from a related population. Population and genetic trajectories in our study were most sensitive to sex and number of individuals translocated and translocation frequency. Translocation of females produced consistently higher population, allelic richness, and heterozygosity compared to equal numbers of males. Despite population increases, declines in allelic richness and heterozygosity across simulations were stark, with simulations predicting a mean decline of allelic richness and heterozygosity of 46.5% and 53.5% without intervention, respectively. Translocations of four females every generation or every other generation were required to prevent substantial heterozygosity declines. While translocations could increase population size, they may fail to prevent long-term loss of genetic diversity in small populations unless applied frequently. This reinforces the importance of incorporating realistic processes of genetic inheritance and gene flow in modelling small populations.

Behaviour

Erzinçlioğlu, T. S., and Rutherford, K. M. D. (2023). Using qualitative behavior assessment to investigate the effect of tourist presence on the welfare in captive tigers (Panthera tigris) in three tourism facilities in Thailand. Zoo Biology.

ABSTRACT

Numerous facilities around the world offer tourists interactive experiences with captive tigers. Yet, the animal welfare implications of this practice have not been widely studied. This study

aimed to investigate whether qualitative behavioral assessment (QBA) could: (i) provide a valid indicator of tiger's emotional state and (ii) be applied to assess whether unfamiliar human presence with hand-raised captive tigers had an impact on the emotional state of those tigers. To investigate this, QBA was applied to video clips of hand-raised captive tigers from three sites (two offering unfamiliar human interaction, Sites A and C, and one retirement site with no direct interactions, Site B) in Thailand. QBA allows inferences to be made about animal emotion on the basis of descriptions of behavioral expression. Analysis, using a free choice profiling methodology, was provided by observers (N = 38) split between three groups; tiger keepers and vets from the Thai venues (n = 12), UK-based animal behavior MSc and vet students (n = 16), and international tiger keepers (n = 10). Tigers (N = 35) were split between Sites A (n = 7), B (n = 18), and C (n = 10) and filmed at three time points; morning (0800-0930 h); midday, (1130-1230 h); and evening, (1630-1830h) totaling 105 clips. Using generalized procrustes analysis, a consensus profile was calculated for each observer group. Two meaningful dimensions of behavioral expression, explaining 75.0% of the variation, were observed across these groups: Dimension 1 (D1: “active”/"interested"/"agitated" to “relaxed”/"calm"/"chilled-out") and Dimension 2 (D2: “bored”/"stressed"/"frustrated" to “relaxed”/"curious"/"interested"). There was clear agreement between the three observer groups in terms of tiger emotional expression along D1. However, agreement was more variable on D2. The behavioral expression on D1 was not significantly affected by site but was significantly affected by an interaction between age and time of day. Time of day also affected scores on D2, with the Thai observer group also showing an effect of site. During the midday period, when unfamiliar humans were present, all tiger age groups showed more positive behavioral expressions on D1 (lower scores: “relaxed”/"calm"/"chilled-out") and more negative behavioral expressions on D2 (higher scores: “bored”/"stressed"/"frustrated"), which could indicate that the presence of unfamiliar humans was a stressor. However, tigers in the retirement Site C also displayed similar behavioral expressions, which could indicate a deeper welfare issue. With further development, QBA could be used as part of a valid tool for long-term measurement of behavioral expression in captive tigers.

MONITORING AND ASSESSMENT

Vinitpornsawan, S., and Fuller, T. K. (2023). A Camera-Trap Survey of Mammals in Thung Yai Naresuan (East) Wildlife Sanctuary in Western Thailand. 13(8), 1286.

ABSTRACT

The Thung Yai Naresuan (East) Wildlife Sanctuary (TYNE), in the core area of the Western Forest Complex of Thailand, harbors a diverse assemblage of wildlife, and the region has become globally significant for mammal conservation. From April 2010 to January 2012, 106 camera traps were set, and, in 1817 trap-nights, registered 1821 independent records of 32 mammal species. Of the 17 IUCN-listed (from Near Threatened to Critically Endangered) mammal species recorded, 5 species listed as endangered or critically endangered included the Asiatic elephant (Elephas maximus), tiger (Panthera tigris), Malayan tapir (Tapirus indicus), dhole (Cuon alpinus), and Sunda pangolin (Manis javanica). The northern red muntjac (Muntiacus vaginalis), large Indian civet (Viverra zibetha), Malayan porcupine (Hystrix brachyuran), and sambar deer (Cervus unicolor) were the most frequently recorded species (10–22 photos/100 trap-nights), representing 62% of all independent records, while the golden jackal (Canis aureus), clouded leopard (Neofelis nebulosa), marbled cat (Pardofelis marmorata), and Sunda pangolin were the least photographed (<0.1/100 trap-nights). Species accumulation curves indicated that the number of camera trap locations needed to record 90% of taxa recorded varied from 26 sites for herbivores to 67 sites for all mammals. TYNE holds a rich community of mammals, but some differences in photo-rates from an adjacent sanctuary and comparisons with other research on local mammals suggest that some species are rare and some are missed because of the limitations of our technique. We also conclude that the management and conservation plan, which involves the exclusion of human activities from some protected areas and strict protection efforts in the sanctuaries, is still suitable for providing key habitats for endangered wildlife populations, and that augmented and regular survey efforts will help in this endeavor.

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